THEME 4

Forest Biodiversity and Landscapes

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P. R. Sinha *

1. INTRODUCTION

What is the state of our global biodiversity: How much we have? What is its status? What are the threats? And, what we propose to do to mitigate those threats?

2. GLOBAL BIODIVERSITY

2.1. Assessment of number of life form varies depending upon the data source you are drawing upon. As per one estimate 1.9 million species have been identified out of estimated 10-12 million possible life forms. Out of the 1.9 million known species, Red List assessment by SSC of IUCN is carried out for 48,000 species. We have some idea about the status of these species in wild habitats. But is it adequate to understand status of wild biodiversity? How many species we need to assess to have a fair idea of state of biodiversity on this planet? Scientists, in one paper, have talked about Biodiversity Barometer. They say that we need to asses 1,60,000 well chosen species for a good barometer for informed decision making. The cost of this estimation/ assessment is US$ 60 million. We are at the moment spending only 4 million/year on studying 48,000 species in our Red Listing assessment. The question is who will pay for it. The fact, therefore, is that we are losing our flora and fauna even before we know them. Now let us talk about health of our planet earth in terms of its biodiversity. As per the Economics of Ecosystems and Biodiversity (TEEB) report, global forests have shrunk by approx 40% in the last 300 years. Since 1960, the world has lost about 50% of its wetlands. This has huge implications for recharging of aquifers and water balance. In the past two decades, 35% of the mangroves have declined. Some 30% coral reefs have been seriously damaged through fishing, pollution, disease and coral bleaching.

2.2. As per Millennium Ecosystem Assessment process which was completed in 2005 by more than 1,360 scientists working in 95 countries has estimated that population size or range (or both) of the majority of species is declining across range of taxonomic groups and extinction rate of species are 1000 times the background rates. It also said that distribution of species on earth is becoming more homogenous. Between 10 and 50% of well studied higher taxonomic groups (Mammals, birds, amphibians, conifers, or cycads) are currently threatened with extinction. Genetic diversity has declined globally particularly among domesticated species.

3. CAUSES OF BIODIVERSITY

3.1. Five major causes have been identified globally. These are:

3.1.1. Habitat loss, fragmentation and degradation.

3.1.2. Unsustainable use of ecosystem and overexploitation of resources.

3.1.3. Invasive Alien species [Around 4,80,000. As have been introduced around the world. Estimated cost of damage and control reach almost 5% of global GDP (US$ 104 Trillion/year).]

3.1.4. Pollution

3.1.5. Climate change

3.2. All these five factors causing biodiversity loss are unrelenting. Just as reckless spending is causing recession, so reckless consumption is depleting the world's natural capital to a point where we are endangering our future prosperity. The loss of biodiversity of crops which are important from the point of view of our food security is equally alarming. Mexico, where corn was first developed 7,000 years ago, has lost 80% of its varieties. India has lost 90% of its rice varieties and China 90% of its wheat varieties. In U.S., nine out of ten varieties of vegetables and fruit which were cultivated a century ago have vanished. That is not to mention the extinction of a staggering 6,800 of 7,100 named varieties of apple cultivated there in 1,800. Such losses could have devastating effect on world's food security as germ plasm variability which could have withstood climatic oscillations are not available today to fall back upon.

3.3. Taken together all these facts, we are faced with a situation, where our forests and other natural resources are not able to provide Ecosystem services in the same manner and quantum as they were providing earlier. In fact, MEA 2005 says that out of 24 services that make direct contribution to human well being – 15 are in decline. The world leaders have been giving to themselves targets to halt and reverse this process of degradation but every time they meet they find that these targets have not been achieved. At Nagoya, Japan, we adopted what is called as Aichi Targets – a set

* Director, WII, Dehradun, Uttarakhand

of 20 actions – as part of Strategic Plan for Biodiversity for 2011-20. Only time will tell how the world fares to achieve these targets. Business as usual approach will land us again in a situation where we would be setting another timeline.

4. BIODIVERSITY: THE INDIAN SCENARIO

Coming to global to national level, we are not doing very bad compared to other countries though it should not be a matter of satisfaction for us. We are more vulnerable than many other countries to biodiversity loss as it impacts not only livelihood of millions but compromises our aspirations for removal of poverty and improving quality of life. We have some good stories to tell to the world. We are doing quite well in terms of maintaining green cover – in fact we have registered marginal increase in forest cover. We have done well to conserve our flagship & charismatic species – like the Asiatic Lion, the Wild Ass, the One Horned Rhino and of course, the Tiger. Conserving these species means we are conserving our forest biodiversity as these animals are good indicator of habitat condition. However, we are not doing well in case of grasslands, coastal and marine ecosystems and alpine habitats. Unrelenting cattle grazing and fishing are causing depletion of these ecosystems. Perhaps lack of systematic and periodic assessment of key elements of our ecosystems at national level on the lines of Red Listing programme is not giving us correct picture of biodiversity loss in time and space. I have a feeling that the rate of loss of bath flora and fauna is much more than what we know. To substantiate it let'us examine some facts from the database generated by WII for 17 Tiger Range States in the country. As part of All India Exercise conducted by Wildlife Institute of India (Wildlife Institute of India) under the aegis of NTCA, WII collected data on Tiger distribution, as well as co-predator and prey species along with habitat quality. It has been found that out of 6,31,695 sq. kms. of recorded forest area in 17 Tiger Range States, Tiger presence in 2010 was only over 81,881 sq. kms. It comes to 12.96% of the forest area. The ubiquitous and resilient leopard has been recorded in 23.29% of the forests. Poor Dhole (The Wild dog) presence has been recorded in 18.82% of forest area. Coming to prey base, Chital occupies 24% and Sambhar 19% of forest area. Though the entire 6 lakh recorded forest area is not potential habitat for either Tiger, Leopard, Chital or Dhole, it nevertheless gives indication that major part of our forest are devoid of large mammals. This is a clear indicator of degradation of our forest in terms of herbs, shrubs, and grasses which support the prey biomass. The mapping and evaluation of forests has shown that we have today forests fragmented in six separate landscape complexes. Earlier, a few decades back, these six landscape complexes of forests were connected. Within these six separate complexes also fragmentation has happened. The protected areas are becoming isolated/ island in the midst of incompatible forestry and land use practices. These islands are getting impacted with new and emerging threats like growth of infrastructure around them including tourist infrastructure. Instead of focussing on vast vacant forests outside these Protected Areas for experimentation on new strategies for conservation, these areas are being subjected to various types of activities in the name of sustainable use. There is debate on strict protection strategy vs. coexistence with human beings, tourism vs. no-go areas, people vs. tigers etc. with people taking strong positions on issues. While these debates are welcome, we should be careful in sieving out facts from opinions. We have enough and credible data to say today that if you want to conserve Tigers and other large animals, we need large inviolate breeding areas with surround and connectivity corridors having compatible land uses with low cattle/ human footprint. The bottom line is that we cannot have very high human and cattle density and still have good forest biodiversity. Everyone knows the concept of carrying capacity. Any number of human and cattle beyond a threshold would necessarily degenerate the habitat. Even wild herbivore in an enclosed habitat would degrade it if their number is beyond its carrying capacit

5. END NOTE

In view of above, we must continue our effort to systematically reduce biotic pressure from our protected areas, which constitute 4.9% of our forest area. It will improve its biodiversity richness and enhance ecosystem services. We should manage vast stretches of our green cover around these Protected Areas, (referred to as vacant forests) referred above in a manner that prey base is revived gradually. It would not only improve biodiversity but take care of man-animal conflict to a very great extent. Biodiversity loss and degradation could be halted and reversed only when we manage our forests as a matrix of core or inviote, buffer and corridors to have connectivity of core areas at landscape level.

Conservation of Biological Diversity in the Wild at Multiple Scales

V.B. Sawarkar

INTRODUCTION

Charles Darwin and Alfred Russell Wallace were contemporaries. They worked on distant groups of islands, the former on the Galapagos and the latter on those in the Malay Archipelago. Working separately they hit upon the same theory of evolution of species. Wallace wrote an essay on his work that was presented to the Linnaean Society in 1858. Darwin published his famous work 'Origin of Species by Means of Natural Selection' in 1859 [1, 2]. Today what we speak of the biological diversity has its roots in their initial work that has stood the test time.

What now remains of the natural world on the *terra firma* is mostly classified as forests. Conservation biologists attribute loss of biological diversity to multiple forces that are harnessed and reinforced by human activities. These may act on habitats together or in differing sequences to cause biodiversity losses. These forces are recognized under the acronym HIPPO viz. Habitat destruction, Invasive species, Pollution, Population and Over-harvesting. The prime mover is considered to be the fourth P, too many people consuming too much of land, water and sea space and the resources they contain.

The most powerful current force of habitat destruction is deforestation. Today with wide spread agriculture only about half of the world's original forest cover remains and is being lost at accelerating rates. Indirect drivers of change in ecosystem services are demographic, economic, socio-political, science and technology, cultural and religious. The direct drivers are stated to be the change in land use, introduction of species or removals, technology adaptations and use, external (developmental) inputs, resource consumption, climate change; and the natural, physical and biological factors [3]

INDIA'S BIOLOGICAL RICHES

India represents 2.5% of the world's landmass that supports a population of over one billion people, i.e. 16% of the planet's total human population and 18% of the world's cattle, yet, India is ranked twelfth among the mega biodiversity countries of the world.

There are more than 47,000 species of plants of which 5,150 are endemic, 400 species of mammals (44 endemic), 1,228 species of birds(42 endemic), 496 reptiles (164 endemic), 210 amphibians (121 endemic), 2,550 species of fishes (435 endemic) and more than 60,000 pecies of insects (16,214 endemic) [4]. During 1994, 77 species of mammals, 55 birds, 20 reptiles and one amphibian species were listed by the Zoological Survey of India (ZSI) under the threatened category of species. By 2006 the list of threatened mammals alone had reached 144 species [5].

FRAGMENTED FORESTS AND HABITATS

The pattern of distribution of forests which also are wildlife habitats is best appreciated on the map of India. It will be seen in the form of scattered fragments. Within these fragments there are further innumerable fragments of forest lands or habitats of varied sizes and shapes in a matrix of interspersed habitations, crop fields, lands claimed for infrastructure development and the presence of otherwise legally non-forest category areas. The habitat quality is variable, being arbitered by vegetation structure, composition, density, presence of invasive species of plants and the kinds and intensity of biotic factors. The protected areas (PAs) are part of this reality and share most of these features.

The figure of per capita forest land in India is among the lowest in the world. Against the world average of 0.64 ha and of 0.50 ha for the developing countries, India stands at a per capita average of 0.08 ha. The biomass and the growing stock of wood are just two of the better known and measured manifestations of qualitative loss of forests. These are estimated to be 93 tonne/ha and 47 cmt/ha respectively as against the average of 169 tonne/ha and 113 cmt/ha for the developing countries. This works out to per capita biomass of just about 6 tons as against the average of 82 tonnes for the developing countries [4].

FALLOUT OF FRAGMENTATION ON PEOPLE

The fallout of forest fragmentation on the forest dwelling human societies is very serious and is seldom fully appreciated. It is estimated that the forest dwelling population of tribal communities is in the region of 68 million. There is at this point no clear idea about the population of forest and forest side dwelling non- tribal communities. The typical consequences of forest fragmentation are (i) the increasing interface of forest dwelling communities with societies better adapted to the rough and tumble of the semi-urban areas and urban influenced environment outside the forests (ii) stress between subsistence and market economy, the resultant resource crunch and unsustainable competition, (iii) attrition of forest based resources on which the forest dwellers

are traditionally dependant, (iv) reduced forest regeneration, increased soil erosion, diminishing sources of water, water regime and further degradation, (iv) having to face dislocated populations of wild animals resulting in escalating conflict between several species of wild animals and people that defy lasting solutions [6].

Conflicts between local communities and some species of wild animals have always existed in past [7-8] but lately there is an increase in the incidents. Fragmentation of habitats is increasing the interface between wild animal populations and people with the soft edges becoming hard edges. It is most unfortunate that the basis of conflicts are not acknowledged rather it is falsely believed that because of conservation laws and strategies the populations of wild animals are breeding unhindered and rapidly increasing. The facts are just the opposite. Between the years 2006 and 2010 tigers have lost ground to the extent of 20,845 km^2 or a reduction of 22.24% in their geographic occupancy [9-10]. Species generally involved in the conflict are elephant, tiger, lion, leopard, snow leopard, wolf, the Asiatic black bear and the sloth bear, blackbuck, nilgai and wild pig. Conflicts take place randomly. Locations shift and conflicts vary in intensity. The rapidly rising populations of humans and livestock are potentiating the effects of forest/habitat fragmentation.

FOREST PRODUCTIVITY, BIOLOGICAL DIVERSITY AND WILDLIFE

The term biological diversity or biodiversity was for the first time introduced in management of forests in India via the National Forest Policy 1988 (NFP). Among its 9 basic objectives by implications, conservation of biological diversity has become the policy's central mandate since all intents of other objectives flow from its integrity. Biological diversity is defined as 'the variety and variability of life forms and the interacting ecological processes and functions' [US Forest Service].Maintaining, enhancing and where necessary, restoring productivity has been the central plank of forest management ever since scientific working plans began to drive forest management more than a hundred years ago. The wisdom of sustainable utilization of resources complements it.

In forestry parlance productivity is interpreted by the measures of its assessment that include as examples the quantum of timber produced per hectare or the quantity of an identified forest produce per unit area that may be qualified by quality gradations; by the classification of site quality, by basal area per hectare etc. The straightforward ecological definition of productivity is 'the capacity of soil for producing the whole series of native plants' [11] that refers to the whole range of plant species that naturally occur/could occur at the given location with reference to the biogeographic attributes of the site.

Plants and animals are co-evolved and are interdependent. The simplest example that drives life on earth is the relationship between the pollinators and the host plants. If pollinators are taken out of the equation the concerned plant species will not exist and the entire range of life forms dependent on such plants would collapse. There would be further unpredictable domino effects on animals as well. The relationships are complex and many are yet to be discovered. However, it is a fact that each animal performs key ecological function/s [12] thereby contributing to creation and maintenance of self regenerating and vibrant natural ecosystems. Forests thus are one among such many systems. The proof lies in the evolutionary history, the greatest testament to the fact. By the same token setting aside the technicalities that define the primary and secondary productivity the practical definition of productivity can be stated as 'the capacity of the soil for producing the whole series of native plants and animals'. Thus productivity and biological diversity are analogous.

The forestry sector has allocated specific areas for conservation of biological diversity more commonly referred to as areas for wildlife management. They comprise 99 national parks, 516 sanctuaries, 42 conservation reserves and 7 community reserves that extend over 158,508 km^2 and account for 22.9% of the recorded forests. Outside the PA network wildlife is protected. Although protection is critically important it is not the same as actively managing their habitats and populations. The term wildlife includes any animal, aquatic or land vegetation which forms part of any habitat' [13]. Thus it covers both, the species of animals as well as plants. As such the terms productivity, biological diversity and_wildlife are synonymous with interacting ecological processes and functions being common to all.

In order to maintain the productivity of forests as interpreted by goals of production and use of resources by the local communities and the society at large they represent very small sub sets of biological diversity. To sustain the interest of these sub sets it would be essential to the best of our understanding and capabilities to conserve biological diversity as a whole. In other words it means all of nature's 'cogs and wheels need to be kept intact, whether we understand or not their nature, functions, relationships or purpose' [14]. This also dispenses with the two artificially coined terms, the forest manager and the wildlife manager that are often used to distinguish their roles. They now in this perspective translate into a single term, the forest manager.

FORESTS IN A DIFFERENT PERSPECTIVE

The dictionary meaning of forest is associated with tree dominated vegetation. However there are forest sub-types that are without the element of trees variously comprising scrub, grasses, herbs and swamps. Some examples include the: (1) 4D/2S2 Eastern Wet_Alluvial Grassland comprising swampy grasslands and reeds; (2) 15/C2/E1 Deciduous Alpine_Scrub that is present in the Kashmir part of J&K; (3) 6A/DS2 Southern Euphorbia Scrub- Again a treeless open forest formation characterized by fleshy *Euphorbia* species; (4) 11A/C1/DS2 Southern Montane Wet Grassland- represented by treeless grasslands; and, (5)14/DS1 Sub-Alpine Pastures present in the high elevations of Himalayas [15].

Given the highly diverse characteristics of the recorded forest lands that vary from rainforests to deserts, snow clad mountains and those under permanent ice the term 'forest' could ecologically best be understood as "a unique natural interacting constellation of macro vegetation conditions, micro habitat elements and usage patterns on a land not less than 1.0 hectares and includes potential natural sites on which forests have declined either because of natural environmental random events or under pressures of biotic factors" [16]. The forests are best recognized in terms habitats rather than by any other terms which is consistent with the intents of the National Forest Policy 1988.

BIOLOGICAL AND SPATIAL SCALES

Assessing and measuring biological diversity

Biological diversity is assessed, measured and interpreted at six different levels of biological organizations or scales which are genes, species, communities, populations, ecosystems and landscapes [12, 17, 18]. A branch of ecology referred to as Conservation Biology addresses all these levels for the purpose of effective conservation. Of these, the species, communities and populations are the most convenient levels to work with in the field since these can readily be recognized, assessed and measured via the established field techniques that enable attaining convergence with spatial scales or the extent of area needed for effective conservation. Further it is possible to address the other three levels as the need be. However in the matter of the measure of species, communities and populations unlike the spatial scales, these are not cut and dried. For example the viable population of a species of butterfly may effectively be conserved over the long term within an area of a few square kilometers that has the requisite communities of plant species that serve as food plants, provide cover for breeding, resting and security although several such areas may be needed for the persistence of the species. On the other hand a viable population of tigers may need an area extending over many hundreds or a few thousands of square kilometers [19]. This will depend on the quality of habitat. Among the many interacting factors that determine habitat quality in this instant the density/biomass and distribution of prey population composed of several species is its effective indicator. It will thus be seen that biological scales or organizations have an inherent vagueness but this can be overcome as will be stated later.

One of the strongest laws of evolution addressing the persistence of any species concerns its dispersal and establishment over large geographic units [2]. For dispersal of animals over space, surplus individuals are needed in their populations. Surpluses are provided by 'source populations' or 'source areas' where the rate of recruitment into the population of a species is significantly higher than the rate of mortality. Evolution has also inserted social mechanisms among animals that ensure dispersal of young animals away from their natal areas. However dispersal alone cannot attain the objective of persistence. Favourable circumstances are essential for the purpose of establishment of breeding populations in new areas. This is often fraught with difficulties outside the source areas that usually are represented by 'sinks'.

Sink populations or sink areas are characterized by the rate of recruitment into a population of a species being significantly lower than the rate of mortality, in other words the populations (animals or plants) are on a constant decline unless rescued by the dispersers from the source areas. If efforts are made for the source populations to connect with the sinks and controlling and staging recoveries within the sink populations themselves it is possible to manage persistence of species over much larger geographic units. Such integrated populations are termed metapopulations. The key to effective conservation is management of metapopulations [17]. This can be achieved at the landscape level across its sub units via corridor connectivities. This has been addressed later.

Conservation capabilities of PAs

The average PA size in India works out to 257.47 km^2. There are only 22 PAs larger than 1,000 km^2 in size. The rest, especially in consideration to the average PA size are too small in their respective biogeographic units to secure the future of wildlife in the long term [20]

The statement about small PA sizes not being effective in providing secure long term future to wildlife needs some clarification. Long term security is interpreted as that extending over several centuries. Sometimes it is referred to in the sense of perpetuity. In order to attain the goal a species needs to possess viable or effective population size to maintain genetic variability or heterozygosity that renders the population genetic fitness and provides numbers that could withstand the impacts of random stochastic changes. Different species have varying age structures, breeding habits and sex ratios; therefore in order to overcome the differences the concept of effective population size is used. This does not include non breeding young animals and the older ones past the breeding age. The number fifty of breeding individuals is often considered to provide security to a population over the short period and 500 as that over the long term. The total population size has to be much larger to contribute the requisite breeding adults [57-58]. It follows that to attain such goal and considering species of large mammals that need large spaces, the conservation area has to be very large indeed. What is very large can be derived.

There are further implications**.** Protected areas are located within a matrix of ecologically hostile lands and land uses. Many of these effectively have become habitat islands of various sizes. Barring a few exceptions of PAs that are connected with each other or to other large habitat patches, the rest either are tenuously connected or completely isolated by varying distances from other PAs and suitable habitat patches. What species, communities and population sizes that might occur and persist on such habitat islands is arbitered by their size and shape; degree of isolation; presence or absence of corridor connectivities; processes that control the rates of recruitment and mortality; habitat quality; conservation status, social organization, habitat orientation of species; disturbance regimes and use of resources [21-23]

THE WAY FORWARD FOR CONSERVATION OF BIOLOGICAL DIVERSITY

Protected Landscapes as PAs

A major challenge for conservation assessments and actions is about identifying priority areas that incorporate biological patterns and processes because large-scale processes are mostly oriented along environmental gradients [24]. This situation can be resolved by capturing the largest possible habitat areas referred to as the landscape. There is an established approach to identify and delineate a landscape with the system of protected areas as the cores that are functionally linked and buffered in ways that maintain ecosystem processes and allow species to survive and disperse along connectivities among habitat patches [6, 12]. Simply stated, 'a landscape is a mosaic of interacting land uses with people and their activities integral to it'. A powerful branch of ecology referred to as the Landscape Ecology considers people

and the impacts of their activities its cornerstone. Landscape ecology integrates the important principles of conservation biology and insular biogeography. The conservation implications for a landscape are already well established [24-26]. The area of a landscape could be several thousand square kilometers including habitat fragments of varied sizes and corridors of different features. A landscape provides the big picture perspective of how various land uses and impacts are related to each other and what might be the management options for reducing the ecological contradictions [18].

A landscape accommodates a range of nested smaller spatial physical entities most of which are already on topographical maps such as watersheds, plateaux, spurs, slopes, valleys and smaller sites with which managers are more familiar for the purpose of planning conservation action.

Remote sensing tools and the GIS platform have lessened the burden of conservation planning at the landscape scale. The approach to the 2006 and 2010 assessment for the status of tiger co-predators and prey exemplify this [9, 10] although conservation action at those scales is awaiting land use reforms that currently exist in the conceptual realm. The elephant reserves likewise provide another such example that is considering landscapes [20].

Corridors constitute critical elements for landscapes to be able to function for their intended objectives. Corridors represent physical entities as links between PAs or patches of productive habitats. They need to fulfill three principal objectives (i) conserving habitat suitability for movement of species (ii) maintaining, promoting and supporting ecosystem service (iii) integration of local community welfare [27]. They are like bridges that connect larger ecological patterns and elements of interest.

The structure and nature of corridors can vary considerably. Given the fragmented situation of habitats and pressures on resources they may be (i) narrow and linear but suitable to meet the needs of several species of interest i.e. through their general habitat configuration and sites providing security (ii) there might be discontinuous patches of natural vegetation alternating with patches of land under some form of human use, not unlike a system of stepping stones (iii) a mosaic of natural cover (iv) riparian systems are among the best examples of functional corridors. They might be linear but have a dendritic pattern that goes across and along the contour features integrating the elevation gradients. In doing so the network connects the whole range of habitats. Security while animals move is provided by vegetation cover of varied structure and composition, even if it might be in form of discontinuous patches that provide sites for resting, shade, food, pools of water. Clusters of rocks, boulders, topographical features such as gorges with or without vegetation likewise support animal movements [3, 6, 28].

Conservation planning for corridors needs: (i) long term planning and commitment; (ii) they are required to be integrate into land-use planning; (iii) institutional arrangements and inter sectoral support; (iv) stake-holder support at multi levels; (v) public awareness and information; and, (vi) the requisite capacity building [28].

The IUCN recognizes 6 categories of PAs. Among these the category V is about Protected Landscapes "where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area" [29, 30]. While ecologists and legal minds together can offer their best shot at defining the landscape category as a PA for the purpose of legislation, to operationalize it in the field it would be necessary to consider linking PAs with the Reserve and the Protected Forests (RF and PF) and all other categories of forests that are under the stewardship of the forest department. There are lands designated as barren and waste outside the control of the forest department which also are habitats for species of plants and animals adapted to these, several of which are threatened [31]. The managed forests are recognized by the IUCN as 'Managed Resource PAs' under category VI.

CONSERVATION OF BIOLOGICAL DIVERSITY AT MULTIPLE SCALES

In order to conserve and maintain wildlife species, communities and populations or making attempts at staging recovery of species it follows that their habitats and ecological relationships need to be addressed. This has a direct reference to the essential components of their ecosystems. Thus the two levels of biological diversity, genes and ecosystems although not convenient for the field managers to address directly, the genes for obvious reasons and ecosystems because of the difficulties in setting their boundaries are integral to management planning and strategies. These are inseparably associated with the visible levels of the three biological organizations cited earlier.

The only way to conserve biological diversity in the long term is to address the remnant natural ranges of the species, communities and populations of the native wildlife which can only happen at the level of the landscape. For this two processes are needed: (i) a means for deriving a landscape size; and, (ii) a technique to incorporate the habitat needs of the native species of wildlife. This could take place on two fronts: (a) verified presence of umbrella species; and, (b) knowledge of human inhabitants of the area and the range of their activities that include the patterns of local economy and processes of development.

(1) Landscape delineation: The vagueness of spatial limits associated with the landscape can be resolved by focusing on species that have one or several of the following attributes: (i) mammals with large body size in general. They often need large spaces and attract conservation efforts. Several of these may feature in conflicts with people so there is another important issue to be addressed, though secondary in nature in the present context [66]; (ii) species that are solitary; (iii) species that are territorial; (iv) those that are wide ranging; (v) species that are rare; (vi) those that have patchy distribution; and, (vii) species that have distinctly separate seasonal ranges of habitats.

It needs to be appreciated that habitat quality greatly influences densities and distribution for all wild animals. Therefore even for a given set of species the size for different landscapes cannot have a pre-ordained size since a number of variables are at play at any given point of time. Landscapes can best meet the interest of the full range of native species of wild plants, their communities

and populations and likewise of animal species, populations and communities that need smaller areas than those species that assist in deriving the landscape limits. Such process also stands to include portions of many ecosystems within the geographic unit in focus. Several landscape units together can effectively conserve most elements of biological diversity. The next step would be to plan for the habitat constituents within a landscape.

The classification of forests by Champion and Seth provides an excellent framework to build upon it a matrix of habitat types. A habitat type for a species needs to have the minimum essential components to be able to lend itself as a practical system of utility in the field. The suggested broad components are: (1) the status of the species; (2) ecosystem/s used that may be described by the Champion and Seth classification by the group type or/and sub-type as relevant; (3) habitat requirements to include: (i) structure and composition for breeding, and rearing the young. Micro habitats as relevant may be used for the purpose; (ii) feeding activities to include the food items and feeding habits; (iii) cover includes vegetation structure and composition for functions like breeding, shelter and security; and, (iv) structural stages required for all functions- these are similar to the stages of succession described in forest management viz. grass-herb, shrub-scrub to mature forest and old growth forests. The narrative and descriptors need to be revised as knowledge of a species improves over time.

(2) Habitat structure, composition and conditions: Conservation cannot be accomplished by the species by species approach; therefore small groups of surrogate species are needed to represent the conservation interest of the rest of the species of wild animals. Such select species are referred to as the Management Indicator Species (MIS). The MIS approach has been criticized for the possible subjectivity that might enter into the process of selection, but if the process is transparent, based on expert consultation followed by extensive literature review, the negative aspects can be overcome. Such species on the basis of the knowledge of their habitat affiliations, distribution and abundance can be used to maintain the desired habitat conditions shared by many other species, each collectively called a guild. A guild can also be constructed around selected parameters such as feeding, nesting or requirements for raising the young etc. These can have further classification by the micro habitats used and other features [6, 12].

CONSERVATION FRAMEWORK

The conservation framework on the ground has to be practical and flexible in the sense that planning and management are enabled to work across adjacent landscapes or their sub-units on the basis of the common objectives and issues.

The important steps in conservation planning need to include: (i) identification of species of 'conservation importance' i.e. species falling under all threatened categories (the IUCN classification of categories) as the case may be [5] irrespective of their current position under the schedules of the Wildlife (Protection) act 1972; those that are endemic, rare, keystone and focal, umbrella and flagship; (ii) setting up data concerning ecological information including population parameters, historical consequences and current impacts of human related activities; all habitat types and hydrological regimes; (iii) determination of conservation values and conditions; (iv) identifying and defining conservation sub-units, corridor linkages and threats; and, (v) setting priorities and strategies [6,32,33] (vi) identifying the range of stakeholders, and an understanding of the political and administrative realities. The local inhabitants, local institutions, civil societies, all government agencies and those representing the private sector become direct or indirect stakeholders since conservation of biological diversity is based on land, its resources and water.

A crucial aspect of conservation planning relates to an understanding of the local people's reaction to it which is based on multigenerational connection, the history of land use and attachments arising there from. Such approach helps in respecting the dignity of people, avoiding any undue conflicts and leading the way to resilient planning [33].

The forest department manages the lands and its resources vested in it through space defined scientific plans. The PAs are managed under wildlife management plans with the principal focus on conservation of biological diversity. The managed forests are managed under the forest working plans which have several sets of objectives that address sustainable production of an inventory of resources, objectives and strategies for catering to the needs of the local communities, protection of sites, soils, moisture, water, wildlife and many other aspects. Concerning wildlife, its protection is the main objective of a working plan. Beyond some fundamental support to micro habitats the prescriptions do not get into active conservation efforts.

This is not for reasons of any lack of interest but because of the breadth of the mandates vested in the forestry sector, the expectations of the society, traditions that go back to almost a hundred and fifty years of forest management. Working plans continue to follow the route charted for production of goods and services. Now with a much improved understanding of biological diversity, especially its significance as the world wide regulator of climate, as the foundation for economic and social development, and with a broad understanding of its drivers, the ethos of forest management need to be and can be shifted suitably. The NFP 1988 provides such mandate. Some changes are already visible.

The unit of area for a working plan is the forest division which has nested administrative sub-units in descending order of hierarchy such as the ranges, rounds and beats. The forest compartment, each of several hectares in extent without a fixed size and shape is the smallest unit of management with permanent boundaries and identity. Forests are managed and tended under silvicultural systems that vary to accord with the nature of resource and management objectives. They are flexible in having several variants. Depending on the treatment the forest compartments are clustered and allotted to operational management units such as the working circle under a common set of treatments. They accommodate smaller spatial units like felling series/periodic blocks, and coupes. There are working circles that even have hands off policy such as the Protection Working circle. A series of marking rules are used to govern and control felling, tending, production operations and conservation of resources. These rules that are integral to silvicultural treatments translate into a box of tools that can be put to use for maintaining, altering and creating varied vegetation structures, composition and conditions

constituting habitats in tandem with the production goals over defined units of area. There is a list of vegetation communities and other resource features that are identified in the field and recorded on a topographic map for each of the compartments. This list can be modified as per the objectives of management and the range of details as necessary. Thus compartments can be used for the purpose of directing the desired habitat conditions arbitered by silvicultural system/s and marking rules under the control of the manager [6, 34, 35]. Each compartment has an annually recorded history of all events that have taken place within its boundaries during that period. Thus there is an effective time honoured system for monitoring and evaluation for tracking the dynamics of change. Accordingly the working plan is eminently in place to integrate the goals for production of goods and services as well as those for conserving biological diversity by maintaining the desired habitat structures, composition, quality and extent over the given planning area via the chosen units of operation. Thus the popular notion in some quarters that forest and wildlife management objectives are incompatible and mutually exclusive can be buried and laid to rest.

In order to be able to attain such objectives it would be necessary to revisit and rewrite the National Working Plan Code, never mind that it was revised recently during 2004 [36]. In tandem, there has to be a field guide and a whole new exercise at capacity building at all institutions of training. Forestry research has to integrate biological diversity as a priority area on its agenda.

Within the forest department at the higher order of integration of forest lands several forest divisions are clustered into a forest circle under the jurisdiction of a Conservator of Forests (CF). Not all of these are necessarily production divisions but may have other divisions designated for afforestation, soil and moisture conservation etc. In short there are land units being managed for different sets of objectives. This is not a problem. Now the nomenclature of these higher order units is changing from circles to regions and officers of ranks higher than that of the CF are manning these in some of the states. Notwithstanding such changes the fact is that a matrix of a series of hierarchical administrative as well as operational units is in existence that assumes a large geographic presence or a landscape. Depending on their location PAs also become part of such a landscape. The presence of PAs is important because PAs represent source areas. Since these are articulating units, PAs can form the core matrix for conservation of biological diversity within an ecologically defined landscape. It follows that for this purpose the working plans for the concerned cluster of divisions need to have appropriate over arching sets of conservation objectives and synergized strategies that are valid for different patterns of habitats across such units within the landscape.

ROLE OF OTHER GOVERNMENT AGENCIES, LOCAL INSTITUTIONS AND THE PRIVATE SECTOR

In India the forest department is the only agency of the government that is directly responsible for the stewardship of the country's natural biological diversity. A few states have a separate department of wildlife in addition to the forest department. Since the natural ecosystems have an extensive and complex interface with human aspirations, demography and activities that carry direct and potential impacts on biological diversity, some of which irreversible, the task of addressing the interest and integrity of natural ecosystems most certainly is far beyond the capacity of the poorly supported forest department.

Forest department has embarked upon several participatory initiatives to address the economy and livelihood necessities of the forest and forest side dwelling communities such as the Joint Forest Management (JFM), and ecodevelopment projects based on efforts at eliciting public support for wildlife conservation around PAs and in and around some of the managed forests [37]. Several have been successful. Examples for PAs include the Periyar tiger reserve and its surrounding areas in Kerala [38]; areas around the Kalakad Mundanthurai tiger reserve (KMTR) in Tamil Nadu [39, 40]. Examples relating to the managed forests include the Harda and Jhabua territorial forest divisions in M.P. [41, 42]. There is a detailed guide for planning ecodevelopment for conservation of biological diversity [43].

There is a need to look at the success of these projects through two separate angles (i) the forest department found it necessary to embark upon such initiatives to address the security of biological diversity because there were no such plans with other agencies most of whom directly or indirectly work for the welfare of people one way or the other via the mandate and responsibilities vested in them. (ii) that such systems of other agencies have focused on outlays and targets rather than on the outcomes which by now is obvious. The lesson learned is that the agencies other than the forest department need to change their approach to addressing public and national welfare on lines with the principles and practices of ecodevelopment. This would go a long way in securing the interest of biological diversity. All plans of development need to have wild animals, plants and ecosystems on the drawing board while plans are being given shape rather than taking recourse to EIAs after making agreements and investments. EIAs of course need to be part of the system.

Although, given the onerous responsibility to the forest department for the stewardship of natural ecosystems and evolutionary processes that have been shaped during the past 3 billion years [44] it gets only about 1% of the nation's budget to conserve nearly 23% of its geographic extent [4]. Most states are cash strapped therefore state sector allocations for this purpose continue to be very poor as well. This is an indicator of the department's status on the totem pole of national importance accorded to the various ministries and departments of the government. This is one of the greatest contradictions, given that security of biological diversity is the foundation of the country's welfare and integrity.

The unit of civil administration for development in the states is the district where the plans of all government agencies and private sector converge or supposed to converge at the same table. The large central and corporate sector projects might feature at much higher levels. Whatever might be the case both, the processes and operations are poorly articulated and coordinated because of the sectoral outlook, lack of overarching policies and mechanisms though collectively all these agencies and the people who supposedly would be the beneficiaries are stakeholders of what happens on and to the land, water and its resources.

The key to effective conservation lies in getting all agencies on a common platform with the security of biological diversity as their mandatory frame of reference. India's Constitution supports this unequivocally. They could continue to have the same objectives they have been given but could approach their attainment through strategies that are sensitive to the integrity of natural ecosystems and outcomes. Such reforms would prompt agencies other than the forest department to pull their collective weight to manage the troubled interface between the natural ecosystems and the welfare of people providing the much needed relief to the forest department to concentrate on their mandate for which it is raised and trained. The outlays for making this to happen could be higher than those estimated through conventional principles because conservation does not come cheaply but it would be a small price to pay to avoid future natural calamities. One of the greatest is currently at our doorstep in the form of global warming and the consequent climate change.

Nothing can stop the forest department from continuing its participatory agenda but to keep going on the present base of poor support and wherewithal would mean spreading thin all of its efforts without making any substantial gains, and facing the risk of losing focus, direction and identity. The message between the lines cannot be louder.

GDP is the index of economic progress. Its contributors are agriculture, industry and the service sectors [45]. Forests and other natural ecosystems that are central to the citizen's welfare, the country's economy and development do not feature as contributors to the GDP. Unless such indices are corrected in whatever terms and factors considered appropriate there will be little compulsion to and motivation for actively pursuing the cause of the country's biological diversity.

Progressive analysts believe that the environmental base is the content of economic growth, not just product yields and currency. Accordingly the real world-view has it that that GDP would need to be replaced by the more comprehensive indicator of progress the GPI (Genuine Progress Indicator) that would integrate estimates of environmental costs of economic activity. Many economists, scientists, political leaders and citizens are increasingly endorsing the concept [46].

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Forest Ecosystem and Biodiversity Management

Dr. A. J. T. Johnsingh *

FOREST ECOSYSTEM AND BIODIVERSITY MANAGEMENT IN INDIA

Geographically, India consists of the mainland in southern Asia, and the islands of the Lakshadweep, Andaman and Nicobar archipelago in the Arabian Sea and Indian Ocean, respectively. It is the seventh largest country by area (3,287, 263 sq.km) and covers 2.3 per cent of earth's surface. With ten broad biogeographic zones viz., the Trans-Himalaya, Himalaya, North-East India, Gangetic plain, Indian Desert, the Semi-arid Zone, Western Ghats, Deccan Peninsula, Islands and Coasts (Rodgers *et al* 2000). India has immense potential for biodiversity conservation. India's biodiversity as number of species includes: mammals (420, 7.7 % of the number in the world), birds (1,232, 13.6%), reptiles (456, 7.8%), amphibians (209, 4.0%), butterflies (c. 1,500, 8.3%) and flowering plants (15,000, 6.0%). Bagchi (2007) gives a succinct introduction to the flora and fauna of India and its neighbours. The most exasperating aspects of India are its human population of over 1.2 billion people, the second most populous country in the world. Nearly 42% of India's population, according to a 2005 World Bank estimate, falls below the international poverty line of US$1.25 a day. The Government aims to achieve and maintain nine percent economic growth. These factors have an immense impact on the forest and biodiversity values of the country.

REASONS FOR INDIA'S RICHNESS

The geological process of great relevance for India's splendid biodiversity started 75 million years ago when the Indian subcontinent, then part of the much larger southern Gondwanaland, broke off and began a northward drift across the then unformed Indian ocean. The drift lasted 50 million years. The sub-continent's subsequent collision and slide under the Eurasian plate resulted in the formation of the Tibetan plateau and the earth's highest mountains – the Himalayas. These mountains abut India in a great chain across the north and north-east, thus acting as a barrier to the rain clouds moving north and creating the characteristic South Asian monsoon climate that sustains its biodiversity (Mani 1974). This newly formed land connection enabled floral and faunal inflows from Ethiopian, Oriental, Mediterranean and Palaearctic biota. With reference to ungulates, for example, there were five species of Ethiopian origin, 17 of oriental, seven of Mediterranean and five of Palaearctic; while 10 became endemic to Indian subcontinent (Rodgers, 1988). In the former seabed immediately south of the newly-forming Himalaya, the movement of the plates created an extensive trough which eventually got filled with river-borne sediments resulting in the formation of the present day Indo-Gangetic plain where the rich alluvial soil gave rise to the formation of the tall grass habitat of the *terai*. The Thar desert lies to the west of the Indo-Gangetic plains and is cut off from it by the Aravali Range. The Aravalis form a barrier to an already weak monsoon approaching from the east and contribute to the deficient precipitation in the Thar.

The original Indian plate, the oldest and geologically most stable part of India, occurs as the Peninsula extending as far north as the Satpura and Vindhya ranges in Central India. These parallel ranges run from the Arabian Sea coast in Gujarat in the west to the coal-rich Chota Nagpur Plateau in Jharkhand in the east. To the south the remaining peninsular landmass known as the Deccan Plateau is flanked on the west and east by the coastal ranges and the Western and Eastern Ghats respectively. The mountains, seas, monsoons, and immigration of flora have enabled the occurrence of various forms vegetation in India. Tropical rain forests are confined to the high rainfall areas such as the Andaman Islands, seaward slopes of Western Ghats, and north-east India. Coniferous forests are confined to the Himalaya and Siwaliks. Between the extremes lie the moist deciduous sal (*Shorea robusta*) forests of eastern and central India, dry deciduous teak (*Tectona grandis*) forests of central and southern India and the babul-dominated (*Acacia* spp.) thorn forests of the central Deccan and western Gangetic plains.

EARLY HUMANS AND VEGETATION IN INDIA

Modern humans originated in Africa and were resident there for a long time. Savannas (2.5 million square kilometers, an area about one-quarter the size of Canada) were possibly created by regular wildfires and man-made fires which were prevalent even in the time of *Homo erectus* (Anon 2011). This vast savannah habitat offered suitable habitat conditions for the origin of 72 antelope species which occur in Africa now (http://www.vertebrates.si.edu/msw/mswcfapp/msw/index.cfm). When humans reached India meandering along the Indian Ocean and Arabian Sea-shore, they would have found that the vegetation was dense over most parts of India except the north-western tract, where the sparse and dry conditions facilitated the evolution of four present day

* Nature Conservation Foundation, Mysore and WWF-India

peninsular antelope species viz. chinkara (*Gazella bennettii*), whose progenitor must have arrived from Africa (Rodgers 1988), chowsingha (*Tetracerus quadricornis*), blackbuck (*Antilope cervicapra)* and nilgai (*Boselaphus tragocamelus*).

FOREST AND BIODIVERSITY CONSERVATION TILL N

Early humans in India were largely nomadic hunter-gatherers and in the course of time they changed over to a more settled agrarian life, which included domestication of various plants and animals depending upon the availability of the species. In the early days the people had access to most parts of the forests although the chieftains had set aside certain pockets of forests exclusively as their hunting reserves. Most of these reserves after independence became part of the existing protected areas. Kulkarni (1982) lucidly traces the history of forest conservation till 1980. Before the advent of British rule in India, there was only customary regulation of people's right over forests and forest produce. This didn't pose a problem then as the forests were vast and the human population was small, kept low by small pox, cholera and malaria, diseases that became treatable only when modern medical interventions were introduced by the British. Even then in certain parts of India people were prohibited from cutting down trees like Banyan (*Ficus bengalensis*) and Pipal (*Ficus religiosa*) by local rules, and certain patches of forests were declared as 'sacred groves' where people were allowed to collect only fallen leaves, twigs and fruits and forbidden to cut the trees.

The British realized the commercial value of the forests e.g. teak for building ships for their navy and sal and pine for their railways (Guha 1994), and tried to regulate people's rights through the Forest Acts of 1865, 1878, 1927 and 1935. The Indian Forest Act of 1927 identified three types of forests. Reserve Forests, which were free from all claims, were exclusively designated for the use of Forest Department and forest fringe communities had no rights other than the ones explicitly permitted by the state. Protected Forests provided the communities with certain rights solely for household consumption and not for commercial purposes. Village Forests provided rural communities more concessions in using forests for their livelihood but Government made rules for regulating management of Village Forests. When a Forest Settlement Officer of the Forest Department chose to convert a Village Forest into a Reserve or Protected Forest, the officer gave three months' notice to the communities to contest the case. Communities usually failed to contest successfully because of illiteracy and marginal social status. Prohibition of shifting agriculture or *jhum* in the Forest Act of 1927 led to an acute sense of deprivation among tribal communities (Mitra and Gupta 2009).

The early days of British rule were characterised by total indifference to the needs of forest conservancy, although Dietrich Brandis, the first Inspector General of Forests who documented sacred groves in many places in India, was among the earliest in India to link forest protection with local people. This scientific forestry promoted by the British aimed primarily at sustained timber yield from the forests, often with a heavy bias towards commercially important species such as Teak, Sal, Deodar (*Cedrus deodara*) and Pine (*Pinus roxburghii*). While this helped in conserving large tracts of forests by bringing them under Government control and management, it often reduced tree species diversity and also in many cases made the age gradation more uniform. Thus the natural forests in many parts of India became uniform stands of preferred native tree species. Much later, some areas were also brought under plantations of exotics often replacing mixed miscellaneous forests. Even after independence, the Government continued the policy followed in the British rule to protect the forest from people and not for the people (Kulkarni 1982) and the major first step in this direction was the Forest (Conservation) Act 1980 which transposed the forest from the State List to Concurrent List. The Forest (Conservation) Act 1980, brought strict regulations on diversion of forest land for non-forestry purposes. This brought down forest land diversion substantially from 150,000 ha/year to about 40,000 ha/year, of which 12,300 ha/year is only for regularisation of encroachments and the rest for developmental projects and defence uses While often branded as anti-development, the contribution of this legislation towards conserving India's forests is indisputable and unparalleled.

Some social movements against commercial felling of trees, initiated particularly in the 1970s started bearing fruit in the 1980s. The most important among these was the famous *Chipko* movement in Uttar Pradesh (present day Uttarakhand) which succeeded in effecting a ban on green felling above 1000 m. Gradually such bans were extended to other parts of the Himalayas and many other ecologically sensitive regions of the country. The shift in the priority of forest management from exploitation to preservation, the view that forests are repositories of biodiversity and the source of basic requirement for local people, got a final stamp from the Government in the form of the National Forest Policy, 1988. In 1990 the Government of India came up with the famous Joint Forest Management resolution which provided a platform for the involvement of local people in forest management. Today the forests of the country have innumerable Joint Forest Management and Eco-development Committees, many of which have been functioning well and helping to resurrect forests in their respective areas. There are accusations, however, that the Government has attempted to dilute the Van Panchayat system by increasing bureaucratic control over the councils and taken up the Joint Forest Management and Eco-development schemes only because the traditional regulatory approaches through protection provided by the Forest Department as part of management have not succeeded in abating forest degradation (Mitra and Gupta 2009). Van Panchayats in Uttaranchal were born out of conflicts and compromises that followed the settlements and reservations of forests in the hills at the turn of the last century. The first government approved Van Panchayat was thus formed in 1921. According to recent estimates, there are 6,069 Van Panchayats managing 405,426 hectares of forests (13.63% of total forest area) in the state. Most of these have been carved out of civil (protected) forests under the jurisdiction of the Revenue Department. The area under each Van Panchayat ranges from a fraction of a hectare up to over 2,000 hectares. Bureaucratic control over Van Panchayat is brought in by the introduction Village Forest Joint Management in forest areas under the control of the Forest Department where the control will be in the hands of the Department (Mukherjee 2003).

The Wildlife (Protection) Act, 1972 also underwent three major amendments in 1991, 2002 and 2006, to make it even more powerful, the last being primarily aimed at improving the tiger reserves. Sarin (2003) argues that the constitutional guarantee that tribal people could earn their living from forests was seriously eroded by the Forest Conservation Act 1980 and Wildlife Protection Act 1972. Perhaps the most contentious legislation in forest history of India, which is also the most recent one, is the *Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006,* which recognizes the rights of forest-dwelling Scheduled Tribes and other traditional forest dwellers over the forest areas inhabited by them and provides a framework for according the same. The idea behind this legislation was to undo the historic injustice done to the forest dwelling communities of India while bringing forests under Government control and ownership. The Act provides for providing rights on forest land for habitation or self-cultivation for livelihood up to a maximum of 4 ha to each individual/ family that have traditionally been living in the forests. The only areas where rights cannot be given are the critical wildlife habitats (CWH) declared within existing Sanctuaries and National Parks. CWH means such areas of National Parks and Sanctuaries where it has been specifically and clearly established, case by case, on the basis of scientific and objective criteria, that such areas are required to be kept as inviolate for the purposes of wildlife conservation as may be determined and notified by the Central Government in the Ministry of Environment and Forests after an open process of consultation by an Expert Committee, which includes experts from the locality appointed by the Government wherein a representative of the Ministry of Tribal Affairs shall also be included, in determining such areas according to the procedural requirements under the act. Even after declaration of certain areas within sanctuaries and national parks as CWH after the rigorous process described above, the relocation of people from such areas can take place only after meeting a number of conditions. The number of protected areas in India stands at 599 (including 95 National Parks and two Conservation Reserves) which cover 4.75% of the country's area. With most protected areas having people living in them (at least 65% of the protected areas have people living within, or using them), the process of freeing them from pressures is only becoming more and more difficult, if not impossible.

STATUS OF FOREST COVER IN INDIA

As per the information given by Forest Survey of India (2009) the total forest cover of the country as per 2003 assessment is 678,333 sq.km and this forms 20.64 per cent of the geographic area of the country. Of this 51,285 sq.km (1.56%) is very dense forest, 339, 279 sq.km (10.32%) is moderately dense forest while 287,769 sq.km (8.76%) is open forest cover. The non-forest cover includes scrub and is estimated to cover an area of 40,269 sq.km. In terms of forest cover Madhya Pradesh has got the largest forest cover followed by Arunachal Pradesh, Chattisgarh, Maharashtra and Orissa. With respect to total geographic area Mizoram leads with 91.27% forest cover, Lakshadweep (82.75%), Nagaland (81.21%), Andaman-Nicobar Islands (80.76%), Arunachal Pradesh (80.43%), Manipur (77.40%), Meghalaya (77.23%) and Tripura (76.95%). Arunachal Pradesh has got the largest area of very dense forest cover and Andhra Pradesh has got the largest area of scrub.

Mangrove cover in India accounts for about 3% of the world's mangrove vegetation and is spread over an area of 4,639 sq.km in the coastal states and Union Territories of the country. Sundarbans in West Bengal accounts for a little less than half of the total area under mangroves in India. West Bengal (46.39%) has the maximum mangrove cover in the country followed by Gujarat (22.55%) and the Andaman and Nicobar islands. Very dense mangrove comprises 1,405 sq.km (30.29%), moderately dense mangrove 1,659 sq.km (35.76%), and open mangrove 1,575 sq.km (33.95%). Compared with 2005 assessments, there has been increase of 58 sq.km in mangrove cover mainly because of plantation and protection measures in the states of Gujarat, Orissa, Tamil Nadu, and West Bengal. Decrease in mangrove cover in the Andaman and Nicobar islands is attributed to the 2005 tsunami.

Besides the terrestrial landscape India is home to several types of fresh water habitats. They can be classified as wetlands (waterlogged areas where aquatic plants thrive), brackish water habitats (where salt and fresh water meet; mangrove swamps are common here), marshes (where water is very close to, or above the ground surface for part or most of the year; water logged environment that stays soggy), swamps (wetland areas where water completely or partially submerges the vegetation; reed beds or sedges at the margin; raised areas may be dry and trees grow on them), rivers and streams (water flows in one direction), lakes and ponds (areas of permanent or semi-permanent water bodies depending upon the size and depth) and temporary ponds(dry for most part of the year and filled with water when rains come). In most parts of our country fresh water habitats are neglected and particularly those closer to human habitations are encroached, filled with garbage, sewage and untreated industrial effluents. Eutrophication promotes undesirable flora in the habitat which is detrimental to fishes and birds. Fresh water habitats need the maximum care and protection as they are indispensable not only for biodiversity conservation and fisheries, but also for recharging ground water which is a major problem in many parts of our country.

THREATS TO FORESTS AND BIODIVERSITY CONSERVATION

Problems that threaten biodiversity in our forest areas arise as a result of the unprecedented increase in human population and consumption levels, which have in turn led to planned and unplanned developmental projects. Projects like reservoir and canal construction, needed for the economic progress of the country, lead to clearance and fragmentation of forests and encroachments. Establishment of power lines, paved roads and railways have led to loss of forest cover, fragmentation and death of all forms of animals ranging from butterflies to elephants. Observations by the author in different parts of the country make him believe that speeding vehicles along the roads possibly should be killing more large mammals than poachers. Fires are largely set by the local people to aid in poaching, and to look for and collect antlers, nuts, and fruits, and to promote fresh growth of

grass preferred by cattle. The 281,700,000 heads of cattle, much more than in China (139,721,000), has a detrimental impact on vegetation; and in addition to competing with wild ungulates for food and water, they transmit diseases to them. Buffaloes are known to make waterholes unfit for elephants just by wallowing, urinating and defecating in the pools. Weed invasion is another threat to the country's biodiversity.

India has about 170,000 villages, with a total human population of 147 million, within the vicinity of the forests (Ellsworth 2002) and majority of these people depend upon the forests to meet their basic needs of fuel wood, fodder and small timber. Demand for firewood is on the increase, and with cooking gas price projected to increase steadily in the decades to come, this is going to be a grave problem. In north India, for example in Uttarakhand, firewood cutting arising from the dozen big towns and hundreds of other settlements in the *bhabar* tract is gradually destroying important tiger and elephant habitat. Khatima Range in the Terai East Forest Division, for example, is totally lost to wood cutting by people from settlements in Nepal and India. There are no dedicated, long-term, large scale plantation projects of fast growing species for firewood involving the poor of the land who try to eke out a living by cutting and selling firewood. Most places in North-East India have the persistent problem of shifting cultivation which destroys the quality of the forests. These threats are growing and are serious. Four serious problems are highlighted.

ENCROACHMENT

The growing problem of encroachment has become complicated over the decades. According to Mitra and Gupta (2009) the state created encroachers by taking over many areas the tribals considered as their ancestral property and classified them as state forests while labelling the tribals as encroachers. According to them these actions have undermined the application of Article 338 (9) of the constitution of India which places the protection and welfare of tribal people as a 'sacred trust' of the State. Now besides these tribal 'encroachers' there are state-sponsored encroachers, encroachers who are immigrants, particularly from Bangladesh and Myanmar, and encroachers planted by a widespread organized industry largely driven by the mafia (Upadhyay 2003). Good examples of State sponsored encroachment is seen in Sundar Khal on the right bank of Kosi river between Ramnagar Forest Division and Corbett Tiger Reserve, and in the Kumili Range in Kottayam Forest Division, Kerala, both occurring in the 1970s. The encroachers in Sundar Khal, numbering c.400, came down from the mountains in 1974. Now the population has grown to thousands and the encroachment is 3.5 km long preventing the animals from the Tiger Reserve reaching the river for water. Several efforts made by the Government over the years to evict the encroachers didn't succeed but after recent (around December 2010) incidents of tiger(s) killing a few encroachers, the encroachers have become more amenable to moving out of the area. The encroachers enter the Reserve for collection of fodder, firewood and timber. Encroachment in Kumili Range and widespread cardamom cultivation in the adjoining Devikulam Range of Munnar Forest Division have contributed to the break in the connectivity between Periyar and Anamalai landscape. When encroachers are not evicted, eventually their numbers grow within the forest and the encroachments expand insidiously. As seen from numerous cases in the country, political interference frequently makes it almost impossible for the Government to evict encroachers. With time, it becomes difficult to differentiate encroachers from legal settlers.

SHIFTING CULTIVATION

According to Ranjan *et al* (1999), the current practice of shifting cultivation in eastern and north-eastern regions of India is an extravagant and unscientific form of land use. The evil effects of shifting cultivation are devastating and far reaching in degrading the environment and ecology of these regions. The earlier 15-20 years cycle of shifting cultivation on a particular land has now been reduced to 2-3 years and this has resulted in large scale deforestation, soil and nutrient loss and invasion by weeds. Several studies have quantified the impact of shifting cultivation on wildlife species. In north-east India the endangered fruit-eating gibbons are seriously affected by shifting cultivation which leads to isolation and fragmentation of habitats. Fragmented habitats in turn are eventually destroyed by timber and firewood cutting (Alfred and Sati 1990, Kakati *et al* 2009). Gupta (2001) observed that Phayre's langur (*Trachypithecus phayrei*) and rhesus macaque (*Macaca mulatta*) survived in traditional jhuming areas (20-25 year cycle) but not in non-traditional *jhuming* areas. The frugivorous diet, high territoriality and adaptations for brachiation easily make the gibbons one of the most threatened species in those areas where habitat loss and fragmentation have been intense, particularly when the short fallow period between shifting cultivation does not allow the restoration of species diversity and canopy contiguity in secondary forests (Sati 2011). Raman *et al* (1998), with reference to conservation of forest-specialist bird species, suggest that in areas where shifting cultivation is practiced there is a need to protect and conserve tracts of late successional and primary forests. Raman (2001) observed that the primary forest was the main habitat for specialized forest bird species that are intrinsically rare and altitudinal migrants. Although protection and conservation of relatively undisturbed mature forests is imperative in the core area of the reserve, management in the buffer zone should have long term rotation of shifting cultivation (>10-year cycles) instead of plantation of monocultures. Alternate means of livelihood to cultivators should also be made available. Any effort to find a solution to this vexing problem of shifting cultivation which can lead to encroachment, soil erosion and weed invasion, must involve *jhumias* and approach must be *jhum*-centred. The participatory approach, traditional ecological knowledge, involvement of traditional institutions like *Kebang* in Arunachal Pradesh and local innovations in farming technology must be taken into consideration while testing suitable models. The alternative to shifting cultivation should be a short term strategy which will provide ecological and economic stability to *jhum* but at the same time a wide range of options for land use on long term basis should also be kept on the anvil (Ranjan and Upadhayay 1999). Gupta (2001) traced the history of traditional (20-25 year cycle) and non-traditional jhuming (2-3 year cycle) in Tripura, where in the late 1980s nearly 55,000 families were practicing shifting cultivation, and

concludes that the incentives provided by the Government to grow rubber (*Hevea braziliensis*) and orange (*Citrus sinensis*) have made several hundred families to give up *jhuming*. But Government sponsored monoculture plantations come with their own set of problems as far as maintaining biodiversity is concerned (Anon 2011).

IMPACT OF ROADS, RAIL AND POWER LINES

India has 3.3 million km of road (the second largest road network of any country in the world, second only to the USA), 65,000 km rail track and thousands of kilometres of power lines. Inevitably, a considerable portion of these go through forest areas. These are an essential part of India's development providing for vital needs of transport, communication and power. Raman (2010) points out that linear intrusions such as roads, railway tracks, power lines and canals in natural areas cause habitat loss and fragmentation, spread of invasive alien species, desiccation of vegetation, wind-throw damage to trees in forest areas, increased incidents of fire, animal injury and mortality (e.g. road and railway track kills, electrocution and drowning), changes in animal behaviour, increased developmental, tourism and hunting pressures, increase in pollution, garbage and various disturbances. The railway track going through the small Hollongapar Wildlife Sanctuary (21 sq.km) in Assam, for example, has not only fragmented the Sanctuary but also the populations of species such as gibbon, stump-tailed macaque and slow loris. Periodically, the trains kill animals like capped langur and python (Sharma 2009). In four tiger reserves in Karnataka a Geographic Information System analysis showed that that they have a high road density, around one km of forest road per square km of forest (Gubbi 2010). Road density increases in the tourism zone and the tourism zone in Bandipur Tiger Reserve has a density of 2.25 sq.km of road per square km of forest. Taking just the 800 km of road in Bandipur Tiger Reserve and assessing an average width of 10 m of the road this translates into 800 ha (8 sq.km) of direct habitat loss. Prasad (2009) found that tree death is 250% higher along the roads than forest interior. Raman (2010) concludes that given India's commitment to sustainable development it is necessary that infrastructure development should be carried out without compromising the long-term value of natural areas, their ecosystem services and the prospect of more holistic development.

INVASION OF ALIEN SPECIES

One of the most disturbing developments related to habitat degradation within and outside forest areas in India is the proliferation of unpalatable plants commonly called as weeds. These unpalatable plants are either native in distribution (e.g., *Pteridium aquilineum* in the grasslands of Western Ghats, and *Flemingia bracteata* and *Pogostemon benghalensis* in the sal forests of Kanha TR, *Desmostachya bipinnata* in the Kanha meadow) or introduced (e.g., *Lantana camara, Parthenium hysterophorus, Ipomoea carnea, Opuntia dillenii, Cassia spectabilis, Cassia occidentale, Coffea arabica, C. canephora, Hyptis suaveolens, Eupatorium odoratum, Mimosa invisa etc.*). A study would reveal that number and density of alien unpalatable species in most parts of our country are much more than native species. While exotic species such as *Tithonia diversifolia* and *Poinsettia pulcherrima* do not spread, and have brought immense beauty to the landscapes where they occur, most exotic species as a result of their abundance have caused much more habitat degradation than native species. Degradation is caused because proliferation of exotic species reduces the forage available to both wild and domestic ungulates, and thereby reduces the carrying capacity of the land. In the forest areas this can have a negative significance for large carnivore conservation as a degraded habitat can only support a lower density of wild ungulates and consequently, therefore, a reduced number of large mammalian predators. A worrying example is the spread of *Mimosa invisa* in Kaziranga Tiger Reserve. A rank growth of this thorny straggler would prevent even pachyderms from using the area. It is true that many of our wild ungulates feed on the tender shoots of species such as *Lantana* and *Eupatorium,* simply because these species dominate the landscape. In other words, in locations where *Lantana* and *Eupatorium* dominate the ungulates have very little of other palatable species to feed on. Existing information indicate that *Lantana* is toxic and we are not sure of the long term effect on wild ungulates feeding on a species like *Lantana*. It should also be on record that lots of attention is already given to the control of noxious *Lantana* in many of our protected areas, particularly in the tiger reserves, and this long term conservation program needs enormous dedication. *Prosopis* causes problem by profusely invading the habitats in the dry zones. Although its leaves are not very much relished, the fruits are eaten by almost all ungulates. Its sharp and powerful thorns can be a deterrent, however, to both large herbivores and predators. The quality of the tiger habitat in Ranthambhore Tiger Reserve is undermined by the spread of *Prosopis*. At a great cost and effort it has been controlled in protected areas such as Velavadar NP where blackbuck need open areas for behavioural displays, feeding and yarding, and in Keoladeo Ghana NP where *Prosopis* had invaded every nook and corner of the NP.

Control of *Prosopis* in the newly established Sathyamangalam Wildlife Sanctuary is very crucial as this is the only place in India where tiger, black buck and elephant occur together. *Opuntia dillenii,* which has long and sharp thorns, has taken over at least 100 sq.km in the eastern parts of the Mudumalai landscape. Its eradication, in tandem with the control of *Prosopis* is very crucial to make the forests of the Mudumalai landscape - including the Sathyamangalam forests - a better habitat for blackbuck and chital. *Cassia spectabilis*, planted for ornamental purposes in Bandipur and Bhadra Tiger Reserves in Karnataka, and a species not eaten by ungulates, although wild pigs may disperse the seeds by feeding on the fallen fruits, is a rapidly spreading weed in the two reserves. Lentic habitats are invaded by exotic water hyacinth (*Eichornia crassipes*) which forms a dense mat and floats on the surface, and by pink morning glory (*Ipomoea carnea*) which grows densely along the edge of the water. Both species are deterrent to aquatic birds. These weeds reduce the quality of the lentic habitat significantly (Johnsingh 2011). Other problematic exotic aquatic weeds are *Salvinia molesta, Alteranthera phelexeroides, Polygonum hydropiper* and *Pisticia stratiotes* (G. S. Rawat, pers. comm.).

CONCLUSION

Suggestions to strengthen biodiversity are to settle land and property right regimes across the country and develop a knowledge-based participatory land-use policy framework involving all categories of right holders. The categories of land-use can be strictly protected areas, multiple use areas, and production areas. This should be followed by setting up flexible institutions and incentive systems to maximise biodiversity conservation. The goal should be to minimise loss to humans arising as a result of conflict with wildlife in strictly protected areas, and to encourage sustainable production practices that would have the least impact on biodiversity in areas identified for biomass production. There should be a provision for regular public and peer scrutiny and review for achievement of land-use objectives, which should have periodic course corrections, say at 5-10 year intervals. The problems listed above can only be reduced, if not eliminated, only with the help of the people. There are several small, small success stories in the country like the regeneration of 700 ha forest in Uffrain Khal (Uttarakhand) where 30 years of dedication by the villagers has resulted in a lush forest, with thick humus on the forest floor and five streams that now have water throughout the year (Kaur 2011). This needs to be replicated all over the country, in landscape after landscape.

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Studies on Seed germination, Viability and Propagation of Endangered *Salvadora oleoides* Decne (Jaal): Haryana Experience

Jagdish Chander *

INTRODUCTION

Haryana is a small state of Indian Union having land area of 43,910 sq. km. Over 82% area is under agriculture, 3.9% under forests and over 13% under other land uses. Climatically the mean annual rainfall in the state varies from a low of 217 mm to 1,097 mm. 65% of the area of the state is arid and semi-arid climate with recurring drought. Frost is common in drier areas and hailstorms occur in March-April. Temperatures vary from 47°C in summer to 0°C in winter with high diurnal variation.

There are four main agro-ecological zones in the state; Shivalik Hills, Central Plains, the Desert, Aravalli Hills. Most of salt affected area lies in panchayat/common lands also called as Banies. A versatile tree called Jaal *(Salvadora oleoides)* used to be the dominant species of Banies. In vernacular language it is known as Jaal in Haryana, Khakan, Pilava Pilu, Mityal in Gujarati, Pilava in Hindi and Kalawa in Tamil. The related species *Salvadora persica* is not found in Haryana. Jaal occupies an important place in Indian history and culture. In The Mahabharata Book VIII: Karna Parva, Chapter 30, verse 24 mentions the tree species as Sami, Pilu and Karir tree species as "Shami pilu kariranam, vanesu sukhavartmasu) and (*apupan saktu pindis ca khadanto mathitanvita.* Meaning, "When shall I be amongst those ladies eating cakes of flour and meat and balls of pounded barley mixed with skimmed milk, in the forests, having many pleasant paths of Sami and Pilu and Karira!" (VIII.30.24).

Salvadora oleoides is a shrub or small tree, attaining height upto 10 m under favourable conditions. It is distributed in drier parts of India, Pakistan and Iran. Within India, it is distributed in drier and salt affected regions of Haryana, Punjab, Rajasthan, Gujrat, Andhra Pradesh and Tamilnadu. Within Haryana it grows in the saline, alkaline and rocky areas in the districts of Mahendergarh, Rewari, Gurgaon, Faridabad, Palwal, Nuh, Hisar, Bhiwani, Fatehabad, Sirsa, Sonepat, Panipat and Karnal. It is the life line of the people and the fauna of the area where it grows. Its roots and twigs are used as toothbrush. Its toothbrush is reported to have antibacterial activity. The leaves are used as fodder for camel and goats. The hare loves to chew its leaves. Various birds like Flame Backed Wood Pecker, Doves, Bulbuls and Bea Eaters love to use this tree as shelter. The older tree develops hollows and birds like Wood Peckers and Parakeets lay their eggs in its hollows. The tree provides an excellent shade in summers and animals and human beings love to sit under it during hot summers. The fruits which ripen during late May and early June are yellow/ pink/deep orange coloured, and are edible. They are sweet and are rich source of anthocyanins. The consumption of its ripened fruits during summers provides protection against the desiccating effects of hot winds. The fruits are one of the richest sources of calcium and contain 15 times more calcium than wheat. The seeds are rich in lauric and myristic acid which have industrial value and are used for soap making.

In the present context, what makes Jaal *(Salvadora oleoides)* important is that it is vanishing from the village forests, village ponds, common lands, saline and alkaline land and hard rocky terrain. There are only old trees and young and middle aged trees are absent. Its habitat is shrinking and is moving away from the northern side. It has become endangered in Haryana. Since the last two decades or so, the seed setting is not taking place. So much so that the present generation has not seen its sweet fruits. The taste of sweet peels has become a thing of past for them and remains mentioned in the history books. Even the pictures of its fruits are also not available. The flowering takes place but seed setting does not take place as all flowers are shed before they are converted into mature seeds. Various reasons have been cited for non setting of seeds. One of them is the change in climate. They say reduction in the period of loos (hot winds), heavy lopping of trees for fodder and for making tooth brush; are some reasons for its becoming endangered. Absence of seed setting is leading to shrinking of its habitat. Also due to bringing banies (village forests) under crop production, its seed production has stopped totally.

Not much value has been attached to it in the past and therefore, not much information is available about the seed germination, seed weight and viability. The literature cites growing Jaal through seed only. No efforts have been made in the past to grow it through root shoot cuttings to get faster growth and also tall plants to ensure higher survival in the field. No efforts have been made in the past to study the effect of manures and fertilizers on the growth of the seedlings. Though by chance, the year 2010 turned out to be a good seed year for Jaal in Haryana

*Conservator of Forests, Govt. of Haryana, Forest Department, Panchkula. E-mail: jagdish.chander@ Hotmail.com

and no opportunity was lost to collect its seeds. The seeds were collected from Mahendergarh, Hisar, Sirsa and adjoining areas of Rajasthan. Hence the present study was undertaken with an objective to study seed quality, storage and germination and seedling growth and establishment in field as well as nursery.

MATERIAL AND METHOD

In year 2010 ripened fruits (called peels) were collected in the first week of June from Mahendergarh and Hisar districts of Haryana, and Rajgarh area of Rajasthan. The following methods were adopted for study

Seed weight studies

Seeds were collected from three different locations viz. Bir Hisar, Mahendergarh and Rajgarh, depulped and thereafter dried in shade. The dried seeds were weighed after a week of drying and number of seeds/one kg were counted.

Germination studies

Jaal fruit pulp is reported to have germination inhibitors. Therefore, some seeds were depulped and were dried under shade. Two hundred shade dried seeds were sown in two germination trays each. Also two hundred fresh seeds with intact pulp were sown in two germination trays separately. The germination study was conducted at room temperature of 27°C. Proper moisture level was maintained in the trays by sprinkling water as and when required.

The germination studies in the field were conducted in following ways: (1) By sowing of pulped and depulped seeds in the germination trays separately at Bithmarha in Hisar district; (2) By sowing depulped seeds in polybags of size 15cmx22cm in nursery at Bithmarha in Hisar district; and, (3) By sowing depulped seeds directly in soil in beds of size 10mx1m.

Seed storage and viability studies

For this purpose the seeds were depulped and were dried in shade. These seeds were stored at room temperature at Forest Seed Testing Laboratory, Pinjore in district Panchkula. The study was conducted in germination chambers of Forest Seed Testing Laboratory Pinjore. One hundred seeds were sown separately in two germination trays at an interval of seven days and the number of seeds germinated was counted. This process continued till the germination dropped to 20 percent.

Study on raising tall seedlings of Jaal

The study on the possibility of making tall plants was conducted at Bithmarha in Hisar district. For this purpose the seeds were sown directly in the nursery beds of size 10mx1m in the month of June, 2010. The plants were maintained in the nursery beds upto first week of February. Thereafter, these plants were uprooted in the first week of February. They were used for making stumps having about 10 cm of root portion and 5 cm of shoot portion. The root shoot stumps so prepared were planted in the following commonly used containers in Haryana Forest Department for raising plants. The following method was used:

A: The pot mixture containing FYM, sand, silt and clay in the ratio of 1:1:2:1 was used. This mixture was filled in polybags of size 20cmx30cm. 400 prepared stumps of Jaal were treated with 500 PPM of IBA and these treated stumps were planted in the polybags filled with the pot mixture. 400 stumps were planted

B: The same pot mixture and 400 stumps treated with 500 PPM of IBA were planted in bigger containers having size 30cmx45cm.

C: 400 stumps without IBA treatment were planted in polybags of size 20cmx30cm. This was maintained as control and results of IBA treatment were compared with the results of control.

Study on the effect of manures and fertilizers on the growth of Jaal plants

For the purpose of this study, Jaal seeds were sown in polybags of size 15cmx22cm in the month of June. These plants were maintained upto first week of February. Thereafter, in the second week of February with the sharp blade the polythene sheet was carefully removed keeping the soil intact with the plants. 50 such plants were planted in each of the following treatments. For the purpose of studying the effect of manures and fertilizers on the growth of Jaal plants, the following method was used:

A: DAP treatment: Gunny bag of size 30cm x 45cm were filled with 50 gm of DAP thoroughly mixed with local soil. In 50 gunny bags one Jaal plant each was planted.

B: Farm Yard Manure (FYM) Treatment: Gunny bag of size 30cm x 45cm were filled with one kg of FYM thoroughly mixed with local soil. In 50 gunny bags one Jaal plant each was planted.

C: Urea treatment: Gunny bag of size 30cm x 45cm were filled with 50 gm of urea thoroughly mixed with local soil. In 50 gunny bags one Jaal plant each was planted.

D: Vermicompost treatment: Gunny bag of size 30cm x 45cm were filled with 500 gm of vermicompost thoroughly mixed with local soil. In 50 gunny bags one Jaal plant each was planted.

E: *Azotobacter* treatment: A non symbiotic nitrogen fixing bacterium *Azotobacter* procured from Haryana Agriculture University, Hisar was applied at recommended dose and was thoroughly mixed with local soil. 50 gunny bags of size 30cmx45cm were filled with this mixture. In each gunny bags one Jaal plant was planted.

F: Control: 50 gunny bags were filled with local soil only and no manure and fertilizer was added. This was maintained as control and plants in this category were maintained like above treatments.

In all case the plants were watered as and when required. The weeding was done once in a month. Shifting was done twice: first in the third week of May and second in second week of June. The height of each plant was recorded in the last week of June.

Since the study did not involve much of data collection and analysis, simple mathematics was used for arriving at results.

RESULTS AND DISCUSSIONS

No information is available as regards the seed weight of Jaal. During study it was found that Jaal seeds become very light on drying. No significant difference in the weight of the seeds collected from three different locations was found. On an average 34,050 (Thirty four thousand and fifty only) seeds were contained in one kg of Jaal seeds.

As regards germination percentage, it was found that at

room temperature no significant difference was found in the germination of the seeds. The germination started after 48 hours of sowing of seeds and it was completed within 120 hours. The germination in pulped and the depulped seeds was found to be around 90 percent. Thereby signalling that it is only the seed setting problem that is making Jaal an endangered species. Once the good seed setting takes place, Jaal can be regenerated very easily.

No information is available on the viability of Jaal seeds. It was thought before the start of the study that Jaal seeds will not remain viable beyond one month. But the present study revealed that Jaal seeds stored at room temperature retain 90 percent viability upto 160 days. Thereafter, the viability starts coming down drastically after this period and seeds became non viable after 170 days. The results of viability studies reveal that the Jaal seeds have to be sown in beds or in polybags upto the month of August in the same year. One cannot wait upto February next as the seeds would become non viable by that time. The sowing cannot be delayed beyond August as the cold conditions start thereafter and in winters no germination will take place. Moreover, Jaal being susceptible to frost, the juvenile plants will be destroyed by frost. Hence, Jaal seeds should be sown immediately after collection.

As regards the raising of tall plants of Jaal with or without root hormone, it was found that the sprouting in the root shoot stumps started after one month. It was further found that no root shoot stump sprouted in the case of control. In the case of stumps treated with IBA 500 PPM irrespective of size of the container, only 10 percent stumps sprouted. However, rooting could take place only in 5% stumps. By the end of June, only 5% plants could survive. The results indicate that the root shoot stumps would not sprout and even IBA failed to induce satisfactory rooting in the case of Jaal. Hence, technique of raising Jaal by root shoot method does not work and should not be attempted.

Jaal responded to manures and fertilizers. The maximum and the average height recorded in the case of manures and fertilizers treatments is given as under:

Height of Jaal (*Salvadora oleoides)* plants recorded in response to manures and fertilizer treatment

S. No.	Treatment	Maximum Height (Cm)	Average Height (Cm)
1	FYM	99	54.54
2	Urea	72	50.94
3	Vermicompost	70	50.32
4	DAP	88	50.04
5	*Azotobacter*	76	46.94
6	Control	64	46.64

Average height was treated as criteria for evaluating efficacy of various treatments as most of the individuals fall in this range. It is evident from the above table that FYM treatment proved superior to all other treatments as regards the maximum and the average height. The maximum and the average height in this case was 99 cm and 54.54 cm, respectively. There is a difference of about four cm between FYM application and second best treatment i.e. urea which is a significant difference. Hence, FYM application is best as regards getting best plants of Jaal. Urea stood second in the average height (50.94 cm). However, its maximum height (72 cm) was lower than that of DAP (88 cm) and *Azotobacter* treatment (76 cm). Vermicompost occupied third place (50.32 cm) as for as for as average height is concerned. However, its maximum height was lower than that of DAP, urea and *Azotobacter* treatments. A maximum height of 88 cm is satisfactory in the case of DAP treatment, but its average height (50.04 cm) is less than that of FYM and is almost equal to urea and vermicompost treatment. An average height of 46.94 cm in the case of *Azotobacter* is lower than other treatments but is almost at par with control. Control registered a maximum and minimum height of 64 cm and 46.64 cm which is lower than all other treatments.

CONCLUSION

Salvadora oleoides has become an endangered species in Haryana. The reason for this is the absence of seed bearing. At present the flowering takes place in some trees but the flowers are not able to become the future seeds. As 2010 was a good seed year for *Salvadora oleoides,* no opportunity was lost in collecting seed and conducting seed and nursery related studies on it. As regards seed weight, it can be concluded from this study that one kg of *Salvadora oleoides* contains about 34,050 seeds. Its seeds retain 90% viability for about five months under room temperature conditions and thereafter its viability starts decreasing sharply. Its root shoot cuttings should not be attempted as mean of having healthy tall plants as the root shoot stumps fail to root. The plants raised from seeds do not tolerate disturbance. They have to be transferred into bigger containers with soil intact. The undisturbed plants respond to manures and fertilizers. However, the FYM application continues to be the best. Application of urea, vermicompost and DAP application gives positive results and are not better than FYM. *Azotobacter* application has very little edge over control. However, the effect is insignificant. Hence, *Azotobacter* does not work well with *Salvadora oleoides.* A combination of organic and inorganic manures and fertilizers can be a better choice. However, this is a matter of future research.

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Species Diversity of the Forest Plants in Nowshera Block, District Rajouri, (J&K), India

L.R. Dangwal, Tajinder Singh* & Antima Sharma

INTRODUCTION

Forest composition, community structure and diversity patterns are important ecological attributes significantly correlated with prevailing environmental as well as anthropological variables and also the vegetation is the outcome of the habitat, environmental condition and existing biotic conditions (Gairola *et al*., 2008; Timilsina *et al*., 2007; Ahmad *et al*., 2010). Although some ethno botanical studies in subtropical belt of the study area have been carried out (Rashid *et al*., 2008; Dangwal *et al*., 2010), but no quantitative data on phyto-sociology of this block is available. The present study describes the existing vegetation structure, species diversity and other vegetation parameters. The finding will be help ethno botanist, environmentalist, ecologists work in other localities of same areas. The present study was conducted in subtropical Chir Pine forest of block Nowshera District Rajouri (J&K) in the year2010-11. The study area is located at an elevation ranges from 500-1200m asl and lies between latitude of 32^0-57' to 33^0-17' N and longitude of 70^0-0' to 74^0-33' E. The study area lies in South-West of the district Rajouri and in Western circle of the Jammu division. It is bounded by block Rajouri in North, Kalakote and Sunderbani in East and Mirpur Pakistan in West and South. Most of the area is mountainous and rugged. Landscape consists of low lying undulating hills and valleys. Northward topography become very steep and high merging ultimately with Pir Panjal range near Ans River. Soil under forest is charcterised by sandstone, shale, clay and calcareous sandstone in lower siwalik and massive, soft, coarse, sandstone with sub ordinate clay in upper siwalik. The annual rainfall ranges from 920-960mm. The minimum and maximum temperature throughout the year ranges from 9^0C to 32^0C.

MATERIALS AND METHODS

The present study area is divided into two sites (**S-1** and **S-2**) based on altitude (i.e., **S-1** from **500-800**m asl and **S-2** from **900-1200**m asl). Phyto-sociological studies were conducted during 2010-11. The plants were indentified with the help of plant taxonomist and the published regional forest flora of Jammu and Kashmir (Sharma & Kachroo 1983; Swami & Gupta 1998). Tree layer was analysed by sampling of ten randomly placed quadrats of 10×10m size in each site. The size and number of samples was quantitatively analysed for abundance, density and frequency (Curtis & McIntosh 1950). Importance Value Index (IVI) for the tree layer was determined by sum of the relative frequency, relative density and relative dominance (Curtis, 1956). The Distribution pattern of different species was studied by using ratio of abundance to frequency (Whitford, 1949). Tree species were considered to be individuals >30 cm cbh (circumference at breast height) and sapling 10-30 cm cbh and seedling <10cm cbh (Saxena *et al*., 1984). The shrubs layer and seedling were analyzed by sampling of quadrats of 5×5 m and 1×1 m randomly on each site. Thus relative value calculated and summed to get IVI. The abundance to frequency ratio was studied for eliciting their distribution patterns. This ratio indicates regular (<0.025), random (0.025-0.05) and contagious (>0.05) distribution of species (Curtis & Cottom 1956).

RESULTS

A total of 56 plant species were recorded from the study area out of which 19 were tree, 10 were shrubs and 27 were herbs. Total species diversity is greater in S-1 than S-2. The result was shown that species diversity is decreased with increase in pure pine forest and shown in table 1 (a&b). In S-1 it was shown greater diversity of trees, shrubs and herbs than S-2 shown in table 1,2 &3 by Simpson index. In S-1 tree diversity in sapling as well as seedling was higher than S-2. Herbs and shrubs diversity was also absorbed higher in forest type-1 than S-2 as shown in table 1.

Tree

In S-1 *Acacia modesta* and *Pinus roxburghii* was dominant species of S -1(IVI= 52.88 & 68.84 respectively) followed by *Dalbergia sisoo*, *Mallotus philippensis, Olea cuspidaa, etc*. (IVI=35.02, 31.77, 22.55 respectively) and the lowest dominant species was *Ficus palmata* (IVI=4.43). While in S-2 *Pinus roxburfghii* was the dominant one (IVI=180.35) followed by *Mallotus philippensis, Pisticia integrasima, Terminalia chebula, Phyllanthus emblica, Terminalia ballerica* (IVI=24.52, 17.27, 11.89) and the lowest dominant was *Ficus roxburghii* (IVI= 4.97) shown in Table:- 1

Sapling

In S-1 *Acacia modesta* was the dominant species (IVI=73.44)

* Herbarium and Plant Systematic Lab., H.N.B Garhwal Central University, SRT Campus, Badshahithaul Tehri Garhwal-249199. Email: tajkhalsa@gmail.com

followed by *Mallotus philippensis, Olea cuspidata, Pinus roxburghii* (IVI=46.93, 39.86, 31.01 respectively) and in S-2 *Pinus roxburghii* was the dominant species (IVI=110.30) followed by *Phyllanthus emblica, Mallotus philippensis, Terminelia bellirica, Grewia vistata* (IVI=34.11, 33.17, 27.28, 22.12, respectively).

Seedling

Higher diversity of seedling was shown by *Mallotus phillipensis* (IVI=101.22) in S-1 fallowed by *Pyrus pashia, Acacia modesta, Cassia fistula* (IVI=72, 39.21, 31.55, respectively) and in S-2 *Pinus roxburghii* was the dominant species (IVI=64.85) fallowed by *Terminalia balerica, Mallotus phillipensis* (IVI=41.50, 40.84), shown in table 1.

Shrubs

It has been recorded that diversity of shrubs was decreased with pine dominating forest. In S-1 *Carisa spinaerum* was the dominant species (IVI=120.51) and *Woodfordia fructicosa* (IVI=181.07) was the dominant species of S-2, shown in table 2.

Herbs

Diversity of herbs was also shown decreased with pine dominating forest shown in table 3. In S-1 *Cynodon dactylon* (IVI=31.87) and in S-2 *Biden pilosa* was the dominant one.

DISCUSSION

The vegetation of Nowshera block was very diverse and similar to other Indian Himalayan forests. The geographical location, climate and topography of the block have contributed to its characteristic vegetation and flora. Area lies to close to the junction of various forest units of world, i.e., Indian, Sino- Japanese, and Afro- Indian Arid plains, etc. The results were shown that *Pinus roxburghii* was the dominant species of S-2 but it also show some sort of dominancy in S-1. In S-1 *Mallotus Philippensis* was the dominant one. Species diversity is more in S-1 representing broad leaved forest as campared to S-2 showning pure pine forest. Shrubs and Herbs diversity was also more in S-1 as compared to S-2 due allelopathic effect of pine forest shown in table 1, 2 & 3.

The regeneration status of trees in both the sites (**S1**&**S2)** was studied by using following guidelines (Koul *et al*., 2008). Good regeneration; if Seedling>Sapling>Adults; Fair regeneration, if Seedling > or ≤ Sapling ≤ Adults; poor regeneration only by Sapling stage but no Seedling. If species is present in adult stage it is considered as no regeneration. Regeneration status of tree species was also good in S-1 as campared to S-2 as shown table 1. Most of the tree species sown regular and random distribution while shrubs and herbs shows contagious distributions as shown in table 1,2 &3.

CONCLUSION

Thus we may conclude that the forest from block Nowshera is chir pine forest needs complete protection from biotic interference, deforestation, grazing and anthropological activities. The Govt. as well as department of Forest should take action for the protection of forest for future generation.

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Dry Season Blooming Tree Species, *Boswellia ovalifoliolata* (Burseracea) and *Terminalia pallid*a (Combretaceae) as Key Food Plants for Insects, Sun Birds During Dry Season in Southern Eastern Ghats of Andhra Pradesh

Hareesh Chandra P, Venkata Ramana K, Samba Shiva Rao, Solomon Raju A J *

INTRODUCTION

The article gives information on floral biology, breeding system, pollination system, pollinators, seed dispersal and seedling ecology of two tropical tree species, namely, *Boswellia ovalifoliolata* Bal. & Henry (Burseraceae) and *Terminalia pallida* Brandis (Combretaceae). The two species are endangered and are also endemics. *T. pallida* is a semi-evergreen species while *B. ovalifoliolata* is a deciduous species. Both the tree species are morphologically and functionally hermaphroditic. *B.ovalifoliolata* and *T. pallida* are entomophilous. *B. ovalifoliolata* is also pollinated by sunbirds. The details of breeding and pollination systems in relation to nectar and pollen characteristics, and pollinator categories have been discussed. Further, the fruit and seed characteristics, seed dispersal mode, seed germination and seedling establishment issues have also been examined and discussed in the light of relevant literature. Finally, important suggestions have been made for effective conservation and management in their natural areas.

MATERIALS AND METHODS

Boswellia ovalifoliolata occurs on the foothills of the Seshachalam hill ranges of Eastern Ghats in Chittoor, Cuddapah and Kurnool districts of Andhra Pradesh up to an altitude of about 600-900 m. Local tribes and others make deep incisions on the main trunk to extract the gum and resin causing damage to trees which in turn leading to the depletion of the plant population in the natural habitat. The gum together with other undisclosed combinations is used extensively to cure a number of diseases: mouth, throat and stomach ulcers, fever, stomach pain, ulcers, scorpion sting, amoebic dysentery, hydrocele, etc. The decoction of the bark is used for joint or rheumatic pains (Henry 2006; Latheef et al. 2008).

Terminalia pallida occurs on rocky hilly areas of dry deciduous forests of Chittoor, Cuddapah and Kurnool districts at 700-800 m elevation in the Eastern Ghats but it is mainly centered at Tirumala Hills of Chittoor, Andhra Pradesh. The leaf is used for treating skin blisters and skin diseases while the stem bark as diuretic and swellings. The fruit is used as anti-pyretic, purgative, for diarrhea, peptic ulcers, diabetes, venereal diseases, cough, cold, dysentery, fissures, cracks and in tanning and dyeing. It is also used as a substitute for the fruit of *Terminalia chebula* (Pullaiah and Sandhya Rani 1999; Madhava Chetty et al. 2008).

Terminalia pallida populations growing on rocky areas at Akasaganga, Papanasanam, Japalitheertham, Srivari mettu and Talakona places of Tirumala Hills of the Eastern Ghats were selected for study during 2008-2010. The Examination of Flower Morphology, Determination of Pollen-Ovule Ratio, Examination of Nectar Production, Determination of Stigma Receptivity, Determination of Inflorescence Flowering Phenology, Determination of Anthesis and Anther Dehiscence, Flower Behaviour, Assessment of Breeding Systems, Determination of Natural Fruit Set, Observations of Flower-Visitors, Examination of Foraging Behaviour of Insects/birds, Observations of seed dispersal and seedling ecology were carried out in both the tree species.

RESULTS

In *Boswellia ovalifoliolata*, the flowers are small, mildly odoriferous and weakly protandrous. The nectar is sucrose-rich and contains some essential and non-essential amino acids which are required by insects. Insects, especially juvenile *Xylocopa* bees and *Apis dorsata* and wasps are important pollinators in effecting cross-pollination. The flowers are not appropriate for birds; however, sunbirds visit them for nectar regularly and pollinate the flowers. Other birds also visit the flowers in quest of nectar due to non-availability of other floral sources but subsequently depart the plant without collecting nectar. Bud and flower feeding by a weevil and flower and fruit feeding by the Palm Squirrel have been found to be greatly affecting the success of sexual reproduction. The garden lizard serves as a predator of pollinating insects, especially bees and wasps; while acting so it affects the pollination rate in this species. Fruit set in open-pollination is below 10% while it is up to 34% in manual cross-pollination. The study suggests that

* Department of Environmental Sciences, Andhra University, Visakhapatnam, Andhra Pradesh 530003, India

limitation of cross-pollination, space constraint for seed production from all ovules of the flower and availability of limited resources to the tree with rocky, dry and limited litter in the floor of the forest seem to be the constraints for higher fruit set. Mature fruits dehisce and disseminate their light weight, papery and winged seeds with the aid of wind. The study site being windy provides the necessary driving force for effective dispersal of seeds away from parental trees. Seed germination occurs following rainfall but the growth and development of seedlings depends on soil water and nutritional status. Field observations indicate that the success rate of seedling recruitment is highly limited and it could be due to nutrient-poor soil and water stress resulting from dry spells during rainy season.

In *T. pallida*, protogyny is a device to promote out-crossing but it is very weak, however it is partly promoted by gradual anther dehiscence over a period of six hours. The flowers offer both nectar and pollen for the foragers; the nectar is hexose-rich and provides some essential and some non-essential amino acids. The plant is entomophilous and cross-pollination is effected mainly by large bees, wasps and butterflies. The natural fruit set stands around 6% as against the 62% fruit set realized in manual xenogamous pollinations. The low natural fruit set is attributed to the plant's inherent capacity, nutrient-poor habitat due to rocky nature with scanty litter availability and high rate of flower-fruit infestation with a beetle species. Fruit predation rate is excessively high by a rodent species, *Funambulus palmarum*. Fruits fall to the ground when mature and dry by abscission but wind is also instrumental in shedding fruits. The fallen fruits are dispersed by rain water and the seeds germinate and establish seedlings depending on the soil status. The study suggests that *T. pallida* does not suffer from pollinator limitation but from fruit predation and rocky nutrient-poor soil for population expansion.

DISCUSSION

The study suggests that both the tree species are subjected to bud or flower or flower and fruit infestation by different beetle species. The beetle species recorded in the respective tree species use the flowers and fruits for feeding and breeding. The rodent species also is a predator on the flowers or fruits of *B. ovalifoliolata* and *T. pallida*. The beetle and rodent species appear to be natural controls to regulate the fruiting and hence seed set rate in the studied forest ecosystem. This is also suggestive of scarcity of floral and fruit sources for these predator species during dry season for their feeding and breeding. The percentage of healthy seeds in the two tree species is small and those that germinate to produce new plants are also subjected to nutrient-deficiency in soil and to competition with the fast growing herbaceous flora and grasses during the growth season at the natural sites. Therefore, flower and fruit predation and infestation by beetles and rodents largely contribute to the endemic and endangered status of the two studied tree species. Seed collection from natural areas and raising seedlings in experimental plots and nurseries for subsequent transplantation into natural areas are suggested for expanding the population size of each of the studied tree species in the deciduous forest ecosystem. Further studies are required for thorough investigation of the reproductive biology of all the constituent species of this forest ecosystem to find out the other host species of beetles and other predators in order to understand the structural and functional aspects of the forest for framing effective measures for the conservation and management of the studied red-listed species

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Plate 9: ***Boswellia ovalifoliolata:*** **a. Tree, b. Flowering inflorescence, c. Position of stamens, d. Pollen grain, e. & f. Pistil, g. *Apis dorsata*, h. *Trigona iridipennis*, i. *Ceratina sp.*, j. *Xylocopa latipes*, k. *Xylocopa pubesceus*, l. *Eumenes conica*, m. *Eumenes petiolata*, n. *Enmenes* sp., o. *Rhynchium* sp., p. *Hyperalonia* sp., q,. *Catopsilia pomona.***

Seed Characteristics and Germination Behaviour of Undehisced Fruits in *Aphanamixis polystachya*: Implications for Reducing Seed Harvest Cycles

Gogate P. P.*, Patil Y. B., Prajakta Y. Sonavane, Rahila I. Boat, Patil M. D., Pooja Y. Pawar, Rane A. D., Gunaga Rajesh P. and Bhave S. G.**

INTRODUCTION

Aphanamixis polystachya (Wall.) R.N. Parker also known as *Amoora rohituka* is a valuable medicinal plant belonging to family Meliaceae. The plant *A. polystachya* is mainly distributed in the tropical areas of Asia such as Southern China, India, Malaysia, and Indonesia (Chen *et al.* 1997) and in India it is distributed in Bihar, Sikkim, West Bengal, Andaman and Nicobar, Arunachal Pradesh, Assam, Meghalaya, Gujarat, Maharashtra, Karnataka, Goa, Kerala and Tamil Nadu(Ganeshaiah 2003).The bark of *A. polystachya* possess astringent, antimicrobial, used for the treatment of liver and spleen diseases, rheumatism and tumours(Chopra *et al.*1956, Graham *et al.*2000, Choudhury *et al. 2003*). A number of limionoids, triterpenes, sesquiterpenes alkaloids and flavonoid glycosides have been isolated from A. *polystachya*. Limonoidsisolated from the seeds and bark (Zhang 2007, Agnihotri 1987), flavonoid glycosides and a chromoneisolated from roots(Jain,1985), triterpenes, guanine sesquiterpenes isolated from stem bark (Chatterjee, 1970, Choudhury 2003)and alkaloid rohitukine isolated from stem and leaves are(Harmon,1979) a key metabolites in *A. polystachya* so also *A. polystachya* bark extracts showed antitumor activity (Graham,2000) radioprotective efficacy (Jagetia and Venkatesh, 2006).This plant is extensively used in traditional system of medicine for various ailments in different Asian countries like spleen and liver complications, tumors, spleenomegaly, liver complaints, tumors, ulcers, diabetes, jaundice, haemorrhoids, burning sensations, arthritis, ulcers, ophthalmia (India), nervousness, pyrexia (Laos) (Asian medicinal plants database). Seed oil is use as liniment in rheumatism(Naskar, 1993). Recently, Azam *et al.,* (2005) have evaluated this species for the biodiesel properties like saponification value (203.8), iodine value (109.1) and Cetane Number (48.52) and they have recommended this species for the biodiesel. *A. polystachya* is enumerated by National commission on agriculture for further research (Nithiyanandam,2002). This species is reported to have have low natural regeneration (ICFRE, 2008-09). Moreover it is one of the species of conservation concerned in south India (Ravikumar and Ved 2000).Seeds of this tree are enclosed in capsule type fruit and seeds are dispersed through hornbill after dehiscence of fruit. (Datta and Rawat, 2008). As tree with low natural regeneration and their seeds being dispersed through birds, it is required to harvest the seeds from undehisced fruits for complete economic utilization. Moreover, the dehiscence pattern of fruits is usually not synchronised, hence for economic harvesting and reduction of harvesting cycle, harvesting of the undehisced fruits from the branch is acutely important moreover to fulfil the requirement of value addition (biofuel and medicine) and mass propagation, sound quality seeds are required with complete economic harvesting.

All the fruits from the bunch were harvested at the time of dehiscence of single fruit from the bunch. All the seeds from the harvested fruits were extracted and subjected to dip and float test in water, an investigation was conducted to evaluate quality of seeds among the undehisced fruits(both dipped and floated on water separately) by comparing them with the dehisced fruits for seed oil content and seed germination. Presowing seed treatment for seeds from naturally dehisced fruits was initially standardized and best treatment was adopted for seeds from undehisced fruits to study the germination behaviour.

MATERIALS AND METHODS

The present study was undertaken at College of Forestry, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Maharashtra. Naturally dehisced fruits (capsule) were harvested from healthy tree around college campus in February 2011. Observation on diameter of seed and length of seed and weight of seed by removing red arillate were recorded. Germination study was conducted in mist chamber with the aim to standardize presowing treatment to improve seed germination. A total of fourteen pre-sowing treatments (seven for each coated and de-coated seeds) were given to the mature seeds collected from healthy plant are as in Table no.2

The experiment was laid down in Randomized Block Design (RBD) with three replications each containing 100 seeds. The seeds were sown in coco pit media in seedling trays were

* gogatepp@gmail.com
** COLLEGE OF FORESTRY,DBS KONKAN KRISHI VIDYAPEETH, DAPOLI, MAHARASHTRA , PIN-415712

irrigated regularly. Sown seeds were observed for 36 days from date of sowing based on daily germination count, germination percentage, mean daily germination (MDG), peak value (PV), Germination value (GV),Germination rate (GR), collar diameter, Root length and Shoot height for each treatment. The extracted seeds from the undehisced fruits were evaluated for ripeness property, if any by conducting dip and float test in water. In this individual seeds from undehisced fruits were decoated, weight and immerse in water and observed. Floated and dipped and seeds were kept separately and sown in coco pit. Sown seeds were observed for 36 days from date of sowing for daily germination count, Germination percentage, Mean daily germination (MDG), Peak value (PV), Germination value (GV), Germination rate (GR), collar diameter, Root length and Shoot height for each treatment. Seeds from naturally dehisced fruits and undehisced fruits (dipped and floated seeds in water) were evaluates for oil content by using soxhlet apparatus using petroleum ether.

Statistical analysis: The data were eventually analyzed using SAS 9.1 software to estimate the extent of variation between the treatments.

RESULT AND DISCUSSION

The seed diameters of the dehisced fruits and undehisced fruits varied significantly (Table No.1). The seeds present in the dehisced fruits had more diameter (13.43 mm) while the seeds (float seeds: 11.96 mm and dip seeds: 12.49 mm) in the undehisced fruits had low diameter. Similar observations were made with respect to seed length, in which the seed length of the seeds in dehisced fruits (19.58 mm) were significantly larger than those present in the undehisced fruits. So also the seeds present in the dehisced fruits were heavier than those present in the undehisced fruits. Interestingly, the seed diameter and length of the seeds of undehisced fruits which swam in water and those of the dipped once was same. Seed characters varied within this tree, this may be due to genes (Zobel and Talbert, 1984) and cross pollination (Wilson *et al.,* 2009). Such variation is common phenomenon among tropical trees (Tokya and Arya, 2005; Narkhede *et al.,* 2008). The average fresh weight of the undehisced fruits was 9.60 g while its dry weight was 3.44 g indicating high moisture content in the epicarp of the fruit. The oil content of the seeds (42%) present in the dehisced fruits was significantly higher than those present in the seeds in the undehisced fruits, however, the oil content of the seeds present both the undehisced fruits; floating seeds (40.97%) and dipped seeds (39.33%) were in line with that of those in the seeds of the dehisced fruits. The seed oil content of this species is in line with that reported by Azam *et al.,* (2005) i.e. 35%.

The fallen seeds from mature fruits were collected and classified into two different sets; with seed coat and without seed coat (seed coat was manually removed) and both sets were exposed to seven pre-sowing seed treatments (Table no. 2). Among all the presowing treatments, the decoated seeds without treatment (control-decoated) produced more germinants (Table no. 2). A similar observation was made by Gunaga *et al.,* (2011) who claimed that seed decayed rapidly in the presence of seed coat of this species. It indicates that removal of seed coat is prerequisite to induce germination in this species. It was also observed that seed coat reduced the germination percent of the seeds with low peak value (1.30 to 1.72) and ultimately effected growth and quality of seedlings. So also, the seedling growth parameters of the seedlings produced from the coated seeds like collar diameter, shoot height and root length were lower than the seedlings produced from the decoated seeds. Luna (1996) observed that removal of mesocarp in *Michelia champaca* produced good germination. Seed coat and surrounding structures may influence the ability of a seed to germinate through interference with water uptake, gas exchange, diffusion of endogenous inhibitors, or by mechanical restriction of embryo growth (Ikuma H, KV Tmmann 1963; Jones R.L. 1974). Moreover, decoated seeds exposed to other presowing treatments produced better germination than that of the coated seeds. As observed, the decoated seeds comparatively responded positively towards water soaking and GA_3 than those seeds with seed coat. Amazingly, the increase in the concentration of GA_3 reduced germination percentage in the decoated seeds. So also, exposure of decoated seeds to the mild concentration of GA_3 (50 & 100 ppm) further improved the seedling growth as indicated by growth parameters like, shoot height, root length and collar diameter which are influenced by peak value. Among growth regulators, Gibberlic acid (GA_3) has been found more effective in stimulating germination of dormant seeds in various species. Mishta and Ashray (1991) observed higher seed germination (70%) and seedling height in *Magnolia grandiflora* seeds treated with GA_3@ 1000 ppm. So also, in *Eucalyptus citriodora*, pre-germination treatment with GA3 (100 ppm) resulted in better germination and seedling vigor (Bhattacharya, A. K.,1991). *Albizia odoratessima* seeds when treated with GA_3 @ 100 ppm showed better germination (33.3%) and took minimum number of days for germination (Moktan *et al.*, 1993). The seed types *viz.* dipped and float seeds collected from undehisced produced nearly same number of germinants when decoated (control decoated), which was the best treatment for the mature seeds (Table no. 4). So also, other germination parameters expect leaf area were same for the seeds which swam in water and those settled deep in the water (Table no. 5). Coincidently, the peak values of the germinants of the undehisced (dipped and float seeds) and dehisced were nearly same (Table no. 4). As in *Casuarina equisetifolia* and *Xylia xylocarpa* pods are collected from tree when few pods on a tree start to dehisce (Chacko *et al.2002*). Capsules of *Michelia champaca* are collected from the tree by lopping off branches when they start opening and seeds with red pulpy covering are seen fallen on ground (Rai,1999). This implies that, even with less germination percentage compared to the matured fruits, the seeds collected from the undehisced fruits in the bunch may produce ample amount of seedlings.

CONCLUSION

The above findings reveal that there is no much variation in the seeds of dehisced and undehisced fruits with respect of seed oil content, seed germination and germination parameters. Observations indicate that removal of seed coat from the seeds eventually improve germination and endogenous application of GA_3 to the decoated seeds results in early and more germination. This study may help in undertaking complete harvesting of those bunches having single or more dehisced fruits in order to attain

additional yield benefits.

Table 1: **Within tree variation in seed traits of *Aphanamixis polystachya***

Fruit	Traits	Minimum	Maximum	Average	SD	SE±	CD (p=0.05)
Dehisced	Seed diameter	11.28	15.04	13.43	0.79	1.06	2.08
	Seed Length	14.99	23.61	19.59	1.65	1.11	2.18
	Weight (de-coated)	0.91	1.73	1.33	0.18	0.16	0.32
Undehisced	'dip' seed diameter	11.26	13.77	12.49	0.63	1.06	2.08
	'float' seed diameter	11.9	14.81	11.96	2.22	1.06	2.08
	'dip' seed length	15.56	18.86	17.34	0.86	1.11	2.18
	'float' seed length	15.07	18.51	16.71	0.99	1.11	2.18
	'dip' seed weight	0.94	1.58	1.19	0.14	0.16	0.32
	'float' seed weight	0.54	1.98	1.09	0.27	0.16	0.32

Table 2: **Names of treatment and other germination parameters for seeds from dehisced fruits**

Treatment		Germination percentage	MDG	PV	GV	GRI
T1	Control	29.0	0.81	1.34	1.08	1.45
T2	24 hours water soaking	30.3	0.84	1.38	1.17	1.35
T3	48 hours water soaking	29.0	0.81	1.30	1.05	1.55
T4	50 ppm GA_3	29.7	0.82	1.32	1.09	1.55
T5	100 ppm GA_3	30.3	0.84	1.43	1.20	1.68
T6	200 ppm GA_3	31.3	0.87	1.72	1.48	1.53
T7	300ppm GA_3	28.7	0.80	1.36	1.09	1.31
T8	Remove red cover	74.3	2.06	2.66	5.49	4.18
T9	Remove red cover+24 hours water soaking	72.0	2.00	2.54	5.09	4.04
T10	Remove red cover+48 hours water soaking	70.7	1.96	3.46	6.81	4.21
T11	Remove red cover+50 ppm GA_3	72.3	2.01	8.70	17.48	6.31
T12	Remove red cover+100 ppm GA_3	68.3	1.90	7.21	13.73	5.65
T13	Remove red cover+200 ppm GA_3	62.3	1.73	3.94	6.86	3.58
T14	Remove red cover+300ppm GA_3	56.7	1.57	2.87	4.52	3.21
SE±		0.54	0.01	0.20	0.40	0.05
CD (p=0.05)		1.12	0.03	0.41	0.82	0.11

Note: For treatment of GA_3 seeds are soaked in water for 24 hours in required conc. of GA_3

Table 3: **Growth parameters of seedlings for seeds from dehisced fruits**

Treatment	Shoot Height	Root Length	Collar diameter	Number of Leaves	leaf area
T1	7.83	6.03	1.522	2	22.012
T2	7.94	6.14	1.537	2	21.672
T3	7.95	6.02	1.526	2	20.984
T4	7.94	5.99	1.499	2	20.606
T5	7.87	5.94	1.504	2	21.54
T6	7.95	6.07	1.49	2	20.965
T7	7.76	6.66	1.483	2	21.567
T8	8.96	6.73	1.686	2.4	24.396
T9	8.76	6.85	1.663	2.4	23.681
T10	8.92	7.27	1.68	2.6	25.009
T11	9.19	7.24	1.736	3.2	32.817
T12	9.17	7.079	1.729	3.6	30.276
T13	8.25	6.82	1.49	2.7	21.856
T14	8.34	6.65	1.488	2.6	21.332
SE±	0.03	0.13	0.019	0.14	0.66
CD (p=0.05)	0.07	0.26	0.037	0.29	1.30

Table 4: **Germination parameters for seeds from undehisced fruits**

Treatment	Germination Percentage	MDG	PV	GV	GRI
Dipped seeds	66	1.83	2.87	5.26	4.08
Floated seeds	67	1.86	2.66	4.95	3.89
SE±	N.S.	N.S.	N.S.	N.S.	N.S.
CD (p=0.05)	N.S.	N.S.	N.S.	N.S.	N.S.

Table 5: **Growth parameters of seedlings for seeds from undehisced fruit**

Seed behaviour in water	shoot heigth	root light	collar diameter	Number of eaves	Leaf area
Dipped seeds	8.89	6.91	1.738	2.7	25.069
Floated seeds	8.71	6.97	1.657	2.7	22.719
SE ±	N.S.	N.S.	0.05	N.S.	1.91
CD (p=0.05)	N.S.	N.S.	0.11	N.S.	4.02

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Ecological Studies of Shrub Species in Chaupal Forest Division of Himachal Pradesh

Zahoor Ahmad Mir* **and Akhlaq A. Wani****

INTRODUCTION

India has rich diversity of flora and fauna due to immense variety of climate and altitudinal zone coupled with varied ecological habitats. Almost all types of forests, ranging from scurb forest to tropical evergreen rainforest, coastal mangroves to the temperate and alpine scurb occurs in India. The altitudinal variation, environmental setting and distinct climatic zones has endowed the state with rich biodiversity, which includes all living forms (species diversity), their intra-specific variation (genetic diversity) and places they are found (ecological diversity).

FLORAL DIVERSITY

Out of total 45,000 to 47,000 floral species found in the country, as many as 3,295 species (7.32%) are found in HP. Himachal has 3,120 species of flowering plants, 38 species of orchids, 13 species of conifers and 124 species of pteridophytes (including ferns). The floristic elements also show high degrees of endemism with almost 95% of the species being native of Western Himalayan flora, while about 5% (150 species) are exotic, introduced over the last 150 years. The introduction of exotics has disturbed the natural composition of many plant communities and is a cause of concern. In fact HP has 12 critically endangered, 21 endangered and 27 vulnerable plant species (Anon., 2011)

The Himalaya accounts for a considerable component of the floristic richness in India, harbouring 40.20% of the total species of fungi and land plants reported from the country. The Himalayan tree flora is also rich, representing 9% of the total angiosperm flora of the region and over 28% of the total estimated Indian tree species (Rodgers, 1985; Dhar, 1996).

STUDY AREA

The study area lies between 30°46′30″ to 31°4′30″ N latitude and 77°24′30″ to 77°49′0″ E longitude and between the elevation of 1200 to 2540 m above mean sea level. In winter, the temperature is −1° C to 18° C and in summer 20° C to 32° C. The average annual rainfall is about 1412 mm per annum with the highest precipitation during rainy season (July -September). The other details of study sites have been given in Table 1.

Table -1: **General description of study sites.**

Site No.	Site Name	Altitude (m)
Site – I	Thekra (UPF)	1500 – 1680
Site – II	Malat (DPF)	1710 – 2400
Site – III	Jawalnu (DPF)	1780 – 2400
Site – IV	Roeshty (DPF)	1972 – 2450
Site – V	Mashmund (UPF)	1772 - 1950

MATERIALS AND METHOD

Five study sites were selected namely Thekra (UPF), Malat (DPF), Jawalnu (DPF), Roeshty (DPF) and Mashmund (UPF) as site I, II, III, IV and V respectively. The studies were conducted by grid pattern method and the vegetation data was collected using randomly distributed 10 numbers quadrates of 5 m x 5 m for all the five sites. Care was taken to sample the most representative area. Vegetation data were quantitatively analyzed for frequency, density and basal area and relative frequency, relative density and relative basal area following method of Mishra (1968). These three relative values were added to get importance value index (IVI).

The Species diversity or Shannon Index (H′)

It was calculated by using formula of Shannon-Wiener (1963) as:

$$H' = -\sum_{i=1}^{n}[(Ni/N) \quad \mathrm{Log}_2(\mathrm{Ni}/\mathrm{N})]$$

Where, H′ = Shannon index, Ni = IVI of the individual species, N = IVI of all the species

Concentration of dominance (Cd)

It is measured according to (Simpson, 1949) and calculated as:

$$Cd = \sum_{i=1}^{n} (Ni/N)2$$

* Research Scholar, Ecology & Environment Division Forest Research Institute Dehradun Uttarakhand
** SMS/Scientist (Forestry), Sher-e-Kashmir University of Agri. Sciences & Tech. of Kashmir Srinagar J&K

Where, Cd = Concentration of dominance, Ni = IVI of the individual species, N = IVI of all the species. It measures a property that is opposite to diversity. Value of Cd lies between 0 to 1, when single species dominates in a community then its value is one.

Sorensen's Index of similarity (S)

It expresses the ratio of common species to all the species found between the communities and is determined by the method given by Sorensen (1948).

$$S = \frac{2C}{A+B}$$

Where, A = Total number of species on site A, B = Total number of species on site B, C = Number of species common in sites A and B

RESULTS AND DISCUSSION

The analytical characters like frequency, density, abundance, basal area, relative frequency, relative density and relative abundance are presented in Table-2. At site I *Cornus capitata* dominated the site with IVI value of 51.518, whereas, *Woodfordia fruticosa* was observed to have lower dominance with IVI value of 19.979. For rest of the species the IVI value varied from 20.522 to 43.838. At site II *Jasminum officinale* showed dominance with IVI value of 72.765 followed by *Prinsepia utilis*, *Berberis aristata* and *Daphne cannabina* with IVI 61.464, 58.239 and 50.574 respectively whereas, minimum value of IVI 25.541 was noticed in *Berberis lyceum*. At site III *Sorbaria tomentosa* and *Rubus ellipticus* was found to be dominant and co-dominant species with IVI values 48.914 and 48.163 respectively. Other associated species were *Zanthoxylum alatum, Berberis aristata, Wikstroemia canescens, Rosa moschata* and *Sarcococca saligna* in terms of IVI values. The minimum IVI value of 26.263 was noticed in *Woodfordia fruticosa*. At site IV Maximum (58.442) and Minimum (16.008) IVI values were recorded for *Sarcococca saligna* and *Cassia tora* respectively. At site V *Sarcococca saligna* dominated the site and *Cassia tora* was found to be least dominated. Maximum (65.633) and Minimum (30.821) IVI values were recorded for ***Sorbaria tomentosa*** and ***Rhus parviflora*** respectively. Other associated species were ***Zanthoxylum alatum*** (64.570), ***Daphne cannabina*** (56.679), ***Berberis aristata*** (47.622) and ***Rosa moschata*** (34.672).

Table 2: **Phytosociological attributes of Shrubs at site - I**

Species	Density (plants/ha)	Frequency (%)	Total Basal Area(m^2/ha)	Relative Density	Relative Frequency	Relative (BA)	IVI
Cassia tora	60.00	30.00	0.013	8.22	8.58	3.731	20.522
Cornus capitata	100.00	50.00	0.082	13.69	14.29	23.533	51.518
Dodonaea visicosa	70.00	40.00	0.027	9.59	11.43	7.534	28.552
Indigofera pulchella	130.00	50.00	0.041	17.80	14.29	11.743	43.838
Murraya koenigii	90.00	50.00	0.013	12.29	14.29	3.884	30.499
Myrsine Africana	110.00	40.00	0.054	15.07	11.43	15.665	42.162
Prinsepia utilis	50.00	30.00	0.031	6.85	8.58	8.796	24.217
Sorberia tomentosa	70.00	30.00	0.071	9.59	8.58	20.557	38.717
Woodfordia fruticosa	50.00	30.00	0.016	6.58	8.58	4.558	19.979

Table 3: **Phytosociological attributes of Shrubs at site - II**

Species	Density (plants/ha)	Frequency (%)	Total Basal Area(m^2/ha)	Relative Density	Relative Frequency	Relative Basal Area	IVI
Berberis aristata	100.00	40.00	0.035	16.39	21.05	20.793	58.239
Berberis lyceum	50.00	20.00	0.011	8.19	10.52	6.818	25.541
Daphne cannabina	150.00	20.00	0.026	24.59	10.52	15.458	50.574
Jasmine officinale	150.00	40.00	0.046	24.59	21.05	27.122	72.765
Prinsepia utilis	90.00	40.00	0.043	14.76	21.05	25.658	61.464
Wikstroemia canescens	70.00	30.00	0.007	11.48	15.79	4.150	31.415

Table 4: **Phytosociological attributes of Shrubs at site - III**

Species	Density (plants/ha)	Frequency (%)	Total Basal Area(m^2/ha)	Relative Density	Relative Frequency	Relative Basal Area	IVI
Berberis aristata	80.00	40.00	0.048	11.94	12.50	12.585	37.025
Rosa moschata	60.00	30.00	0.054	8.96	9.38	14.312	32.642
Rubus elipticus	120.00	50.00	0.055	17.91	15.62	14.628	48.163
Sarcococca saligna	70.00	50.00	0.024	10.45	15.62	6.427	32.499
Sorbaria tomentosa	80.00	40.00	0.092	11.94	12.50	24.473	48.914
Wikstroemia canescens	110.00	30.00	0.026	16.42	12.50	6.758	35.675
Woodfordia fruticosa	80.00	40.00	0.019	11.94	9.38	4.949	26.263
Zanthoxylum alatum	70.00	40.00	0.059	10.45	12.50	15.869	38.818

Table 5: **Phytosociological attributes of Shrubs at site - IV**

Species	Density (plants/ha)	Frequency (%)	Total basal area (m^2/ha)	Relative Density	Relative Frequency	Relative Basal Area	IVI
Berbiris arista	100.00	50.00	0.065	9.43	12.19	13.409	35.038
Cassia tora	70.00	20.00	0.022	6.60	4.88	4.527	16.008
Daphne cannabina	200.00	50.00	0.052	18.87	12.19	10.686	41.749
Debregeasia hypoleuca	70.00	40.00	0.031	6.60	9.76	6.465	22.825
Dendrocalamus strictus	100.00	70.00	0.065	9.43	17.08	13.345	39.852
Prinsepia utilis	110.00	40.00	0.038	10.38	9.76	7.677	27.809
Sarcococca saligna	210.00	70.00	0.104	19.81	17.08	21.558	58.442
Sorberia tomentosa	90.00	30.00	0.064	8.49	7.32	13.296	29.103
Wikstroemia canescens	110.00	40.00	0.044	10.38	9.76	9.039	29.173

Table 6: **Phytosociological attributes of Shrubs at site – V**

Species	Density (plants/ha)	Frequency (%)	Total Basal Area (m^2/ha)	Relative Density	Relative Frequency	Relative Basal Area	IVI
Berberis aristata	120.00	60.00	0.024	19.36	23.08	5.191	47.622
Daphne cannabina	170.00	50.00	0.047	27.42	19.23	10.029	56.679
Rhus parviflora	70.00	30.00	0.037	11.29	11.54	7.993	30.821
Rosa moschata	60.00	40.00	0.045	9.68	15.39	9.610	34.672
Sorbaria tomentosa	80.00	40.00	0.173	12.90	15.39	37.346	65.633
Zanthoxylum alatum	120.00	40.00	0.139	19.36	15.39	29.831	64.570

SPECIES DIVERSITY

A total of 21 species belonging to 15 families represented the floral diversity of study sites (Table-7). For shrubs maximum species (9) were recorded at site-I and IV. Species Diversity (H') maximum species diversity was found to be maximum (2.146) at site-I. Minimum species diversity (1.732) was recorded at site-II. The species diversity ranged from 0 1.732 to 2.146. These values are comparable with the values generally reported for other temperate forests (Ralhan *et al.*, 1982; Singh and Singh, 1987). Monk (1967) and Risser and Rice (1971) obtained 2.30 as the highest value of species diversity index for temperate forests, while Knight (1975) reported species diversity between 5.06 to 5.40 for tropical forests. Lower diversity in the temperate forests could be due to lower rate of evolution and diversification of communities (Simpson, 1949; Fisher, 1960) and severity in the environment Connell and Oris (1964). On the basis of altitude more species diversity was observed at site- IV at higher elevation, it may be due to no biotic interference at higher reaches. InHyeop *et al.* (1999) found that with increasing altitude, number of species, species diversity and evenness increases, suggesting interference by man was relatively severe at lower elevation.

Table 7: **List of occurrence of Shrubs found in study area**

Botanical Name	Vernicular Name	Family	Site				
			I	II	III	IV	V
Berberis aristata	Kashmal	Berberidaceae	-	+	+	+	+
Berberis lyceum	Kashmal	Berberidaceae	-	+	-	-	-
Cassia tora	Elu	Caesalpiniaceae	+	-	-	+	-
Cornus capitata	Haldu	Cornaceae	+	-	-	-	-
Daphne cannabina	Niggi	Thymelaeaceae	-	+	-	+	+
Debregeasia hypoleuca	Shariu	Urticaceae	-	-	-	+	-
Dendrocalamus strictus	Bans	Poaceae	-	-	-	+	-
Dodonaea viscose	Mehndu	Spindaceae	+	-	-	-	-
Indigofera pulchella	Kathi	Papilionaceae	+	-	-	-	-
Jasminum officinale	Malti	Oleaceae	-	+	-	-	-
Murraya koenigii	Kari patta	Rutaceae	+	-	-	-	-
Myrsine Africana	Chapra	Myrsinaceae	+	-	-	-	-
Prinsepia utilis	Bhekal	Rosaceae	+	+	-	+	-
Rhus parviflora	Tungla	Anacardiaceae	-	-	-	-	+
Rosa moschata	Bun gulab	Rosaceae	-	-	+	-	+
Rubus ellipticus	Akhre	Rosaceae	-	-	+	-	-
Sarcococca saligna	Diun	Buxaceae	-	-	+	+	-
Sorberia tomentosa	Bungrae	Rosaceae	+	-	+	+	+
Wikstroemia canescens	Choopay	Thymelaeaceae	-	+	+	+	-
Woodfordia fruticosa	Dhawa	Lythraceae	+	-	+	-	-
Zanthoxylum alatum	Tirmir	Rutaceae	-	-	+	-	-

CONCENTRATION OF DOMINANCE (CD)

It is a measure of dominance of one or a few species in a community. Among the study sites the highest value of concentration of dominance for shrubs (0.185) was recorded at site-II, (Table-8). The minimum concentration of dominance for shrubs minimum value for concentration of dominance (0.103) was observed at site-III. The values of concentration of dominance ranged from 0.103 to 0.185 for shrubs. Similar findings were also described by Whittaker (1965) and Risser & Rice (1971) for certain temperate forests where value of Cd ranged from 0.01 to 0.99. Lowest concentration of dominance amounting only 0.103 was observed at site-III for shruby vegetation showed that habitat is highly heterogenous and dominance is shared by more than one species and hence equitable distribution.

Table 8: **Species Richness (s) Species Diversity (H') and Concentration of Dominance (Cd) of Shrubs at study sites.**

Site	Shrubs		
	S	H'	Cd
I	9	2.146	0.122
II	6	1.732	0.185
III	8	2.059	0.103
IV	9	2.137	0.125
V	6	1.752	0.179

SPATIAL DISTRIBUTION

At site I 66.67 per cent of the species were contagiously distributed and rest of the species represented the random distribution. For site II all the species at the site showed contagious distribution pattern. At site III 62.50% of the species were randomly distributed and rest of the species showed contagious distribution pattern. For site IV all type of spatial distribution pattern was observed. Among these 55.56% species were represented by contagious distribution pattern whereas, 33.33 and 11.11% species showed random and regular distribution pattern respectively. At Site-V shrubs were mostly represented by both random and contagious distribution pattern was observed with equal share. A/F ratio indicates that most of the species among all the sites studied were contagiously distributed and rest of the species were randomly

and regularly distributed. The contagious distribution is the characteristic of natural vegetation and has been reported by several workers (Greig-Smith, 1957; Odum, 1971; Kershaw, 1973; Singh and Yadav, 1974). However, random distribution is found only in very few uniform environments and regularly distribution occurs where severe competition between the individuals exists (Odum, 1971).

β - Diversity
Sorenson's Index of Similarity (S)

The values for similarity index lies between 0.133 to 1.00 for different strata in all the sites studied. Maximum similarity 0.571, 1.00 and 0.571 was observed between site-III and V respectively whereas, minimum similarity (0.133) was recorded between site-IV and V, III and IV and site-I and II respectively. The maximum similarity between different sites (III, V) may be due to same altitudinal zone and similar type of habitat conditions. Less difference in the value of similarity index indicated that growth forms in the stands responded in a similar fashion (Adhikari *et al.*, 1991). The results are in line with the findings of Rawat *et al.*, (1989) and Silas *et al.*, (1987). Whereas, minimum similarity observed between different sites (I, II) and (I, IV), may be due to different climatic conditions and different type of habitat. Itow and Nakanishi (1980) reported that large areas contained more varied habitat types then smaller ones, and each of the habitat type supports a specific set of its own, which is more or less different from that of other habitat types.

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Table 1: **Showing Diversity, Regeneration and Distribution Pattern of Trees in S-1 and S-2.**

Table 1 (a).

S- 1	Tree			Sapling			Seedling		
Name of Species	A/F Ratio	IVI	Simpson index	A/F Ratio	IVI	Simpson index	A/F Ratio	IVI	Simpson index
Dalbergia sisoo	0.032	35.02	0.01	0.000	0.00	0.00	0.100	8.61	0.00
Pyrus pashia	0.100	4.52	0.00	0.050	18.44	0.00	0.069	72.00	0.06
Olea cuspidata	0.044	22.55	0.01	0.067	39.86	0.02	0.000	0.00	0.00
Toona ciliata	0.075	14.44	0.00	0.000	0.00	0.00	0.000	0.00	0.00
Acacia modesta	0.072	52.88	0.00	0.052	73.44	0.06	0.078	39.21	0.00
Ficus palmata	0.100	4.43	0.00	0.100	9.55	0.00	0.000	0.00	0.02
Pinus roxburghii	0.084	68.84	0.05	0.150	31.01	0.01	0.044	29.90	0.00
Mallotus philippensis	0.063	31.77	0.01	0.078	46.93	0.02	0.039	101.22	0.01
Cassia fistula	0.200	7.43	0.00	0.075	21.01	0.00	0.044	31.55	0.11
Syzygium cumini	0.056	18.70	0.00	0.125	29.54	0.01	0.400	17.50	0.01
Flacourtia ramontchii	0.100	4.54	0.00	0.100	9.22	0.00	0.000	0.00	0.00
Phyllanthus emblica	0.075	11.70	0.00	0.000	0.00	0.00	0.000	0.00	0.00
Ficus roxburghii	0.050	9.59	0.00	0.000	0.00	0.00	0.000	0.00	0.00
Grewia vestita	0.100	13.58	0.00	0.000	0.00	0.00	0.000	0.00	0.00
Euphorbia royleana	0.000	0.00	0.00	0.075	21.01	0.02	0.000	0.00	0.00
		299.99	0.096		300.01	0.14		299.99	0.21

Table 1(b).

S- 2	Tree			Sapling			Seedling		
Name of Species	A/F Ratio	IVI	Simpson index	A/F Ratio	IVI	Simpson index	A/F Ratio	IVI	Simpson index
Pinus roxburghii	0.079	180.55	0.36	0.058	110.30	0.14	0.022	64.85	0.05
Mallotus Philippensis	0.089	24.52	0.01	0.067	33.17	0.01	0.078	40.84	0.02
Grewia vestita	0.200	6.34	0.00	0.125	27.28	0.01	0.300	17.96	0.00
Cassia fistula	0.000	7.99	0.00	0.000	0.00	0.00	0.100	8.03	0.00
Phyllanthus emblica	0.100	13.10	0.00	0.067	34.11	0.01	0.044	38.65	0.02
Terminalia bellirica	0.075	11.89	0.00	0.200	12.00	0.00	0.031	41.50	0.02
Terminalia chebula	0.033	15.99	0.00	0.033	22.12	0.01	0.044	36.57	0.02
Pistacia integerima	0.033	17.27	0.01	0.050	14.90	0.00	0.050	18.14	0.00
Ficus palmata	0.050	10.94	0.00	0.050	15.69	0.00	0.100	10.62	0.00
Ficus roxburghii	0.100	4.97	0.00	0.050	14.90	0.00	0.200	14.29	0.00
Pyrus pashia	0.200	6.44	0.00	0.050	15.53	0.00	0.100	8.55	0.00
		300.00	0.38		300.00	0.18		300.00	0.13

Table 2: Showing Diversity and Distribution of Shrubs.

Shrubs	S-1			S-2		
Name of Species	A/F Ratio	IVI	Simpson index	A/F Ratio	IVI	Simpson index
Justisia adhotoda	0.214	71.77	0.06	0.000	0.00	0.00
Dodonea viscosa	0.150	26.84	0.01	0.000	0.00	0.00
Carisa spinarum	0.110	120.51	0.16	0.250	76.83	0.07
Myrsine africana	0.100	8.35	0.00	0.000	0.00	0.00
Nirum indicum	0.700	7.60	0.00	0.000	0.00	0.00
Ziziphus maurtiana	0.300	5.49	0.00	0.200	24.93	0.01
Calotropis procera	0.063	19.08	0.00	0.000	0.00	0.00
Ipomea carnea	0.322	25.67	0.01	0.000	0.00	0.00
Woodfordia fructicosa	0.250	14.68	0.00	0.138	181.07	0.36
Randia tetraspermum	0.000	0.00	0.00	0.100	17.17	0.00
		299.99	0.24		300.00	0.44

Table 3: **Showing Diversity and Distribution of Herbs.**

Herbs	S-1			S-2		
Name of Species	A/F Ratio	IVI	Simpson index	A/F Ratio	IVI	Simpson index
Cenchrus ciliaris	0.000	0.00	0.00	0.875	8.71	0.00
Paspalidium flavidum	0.100	4.96	0.00	0.175	25.69	0.01
Setaria gluca	0.408	17.25	0.01	0.450	17.71	0.00
Setaria sphacelta	0.756	10.22	0.00	0.000	0.00	0.00
Chrysopogon fulvus	0.867	16.88	0.01	0.425	21.29	0.01
Echinocholoa colona	1.389	20.05	0.00	0.344	23.63	0.01
Eriophorum cymosum	1.925	15.06	0.00	1.111	26.26	0.01
Cyprus nubicola	0.000	0.00	0.00	0.825	26.62	0.01
Cynodon dactylon	0.924	31.87	0.01	0.648	35.32	0.01
Biden pilosa	0.506	17.47	0.00	2.100	47.85	0.03
Cirsium arvense	0.163	9.89	0.00	0.100	7.84	0.00
Conyza ambigua	0.522	10.91	0.00	0.100	4.66	0.00
Conyza bonariensis	1.425	10.99	0.00	0.000	0.00	0.00
Parthenium hyterophorus	0.569	24.46	0.01	0.156	11.43	0.00
Silybum marianum	0.300	7.00	0.00	0.350	6.66	0.00
Sonchus asper	0.119	7.45	0.00	0.067	6.98	0.00
Taraxacum officinale	0.069	7.17	0.00	0.050	4.17	0.00
Achyranthus aspera	0.324	18.07	0.01	0.325	7.44	0.00
Amaranthus spinosus	0.081	10.49	0.00	0.000	0.00	0.00
Amaranthus viridus	0.084	10.83	0.00	0.000	0.00	0.00
Capsella bursa-pastoris	0.100	2.88	0.00	0.075	4.23	0.00
Cassia occidentalis	0.225	9.10	0.00	0.575	9.04	0.00
Silene conoidea	0.260	16.05	0.00	1.200	4.46	0.00
Oxalis corniculata	0.875	8.09	0.00	0.000	0.00	0.00
Cassia tora	0.475	4.68	0.00	0.000	0.00	0.00
Sida cordifolia	0.150	3.15	0.00	0.000	0.00	0.00
Malvastrum coromandelianum	0.111	5.00	0.00	0.000	0.00	0.00
		299.97	0.05		299.99	0.09

The Need for an Unified Forest Management Practice to Save Endangered Long Ranging Large Mammals in the Himalayan Foothill Forests of Uttarakhand

DVS Khati

The trans-boundary landscape between India and Nepal along the foot hills of Himalayas, otherwise known as Terai Arc Landscape (TAL) is listed as globally important 200 eco-regions for its unique large mammal assemblage. The Indian portion of TAL, stretching from Yamuna river in the west to Valmiki Tiger Reserve in the east, spreads across five states (Himachal Pradesh, Haryana, Uttarakhand, Uttar Pradesh and Bihar) and encompasses an area of ca. 42,700 km^2 with a forest area of ca. 15,000 km^2. The three charismatic large mammals, tiger, elephant and rhinoceros still inhabit this landscape. Recent estimates reveal the presence of 353 tigers in TAL-India with a tiger occupancy of 6,712 km^2. As per this estimate 227 tigers (64% of the total tiger population in TAL-India) occupy nearly 3476 km^2 of forest in the state of Uttarakhand. Incidentally, the Shivalik Elephant Reserve that extends from Yamuna River in the west till Sharada River in the east encompasses the entire terai-bhabar tract of Uttarakhand. From conservation perspective, the forests of Uttarakhand in the terai-bhabar tract hold immense potential.

Ten identified corridors still maintain the connectivity of forested tract from Yamuna till Sharada in the state of Uttarakhand. Except for two corridors (Chilla-Motichur and Kalagarh), all other identified corridors lie outside protected areas. Tiger and elephant inhabit a matrix of protected areas (Rajaji National Park and Corbett Tiger Reserve) as well as traditionally managed forest divisions (Dehradun, Haridwar, Lansdowne, Terai West, Ramnagar, Terai Central, Terai East, Haldwani and Champawat). Often the level of funding available in forest divisions to protect these highly threatened animals is inadequate and management interventions are not necessarily designed to facilitate dispersal and breeding of these endangered species. Contradictory management practices between protected areas and managed forest divisions often become counter productive for such long ranging endangered large mammals.

In order to have a uniform management practice across the landscape, it is proposed to re-organize the present forest management of the area. The entire stretch of forest along the foot hills of Himalayas in Uttarakhand stretching from Yamuna River till Sharada River is proposed to be brought under one unified control. A landscape level conservation plan aiming to maintain the forest connectivity with due emphasis on wildlife management is proposed to be developed in order to maintain viable population of these endangered species on a sustained basis.

A Study of Floristic Diversity of Sal Forest of Achanakmar-Amarkantak Biosphere Reserve

Bhavana Dixit, Lalji Singh * and Rashmi Agrawal

INTRODUCTION

Nations around the world are required to measure their progress towards key biodiversity goals. One important example of this, the Convention on Biological Diversity's 2010 target, is soon approaching. The target set is to significantly reduce the rate of biodiversity loss by the year 2010. It is well established that loss of biodiversity especially in tropical countries is mainly due to destruction and degradation of the habitat by human activities

Tree species diversity in the tropics varies dramatically from place to place (Pitmen et al. 2002). Much attention has been give to tropical forests due to their species richness (Whitmore,1984) high standing biomass (Bruening, 1983) and greater productivity (Jordon, 1983). In order to effectively mitigate biodiversity loss, grater investment of conservation attention is required in tropical region where there is the more to lose. Broad-reaching global legislation may provide an impact for such investment. One important example is the convention on biological diversity (CBD), under which 190 signatory nations have ambitiously committed themselves to "achieve, by 2010 levels".(UNEP, 2002)

MATERIAL AND METHOD

Study Area

The Achanakmar-Amarkantak Biosphere Reserve is one of the premium biosphere reserves in India. The core region of Achanakmar-Amarkantak Biosphere Reserve falls in Chhattisgarh State (India) and lies between lat.22 ^{0}15' to 20 ^{0}58' N and long. 81 ^{0}25'N to 82 ^{0} 5'E. *Shorea robusta* Gaertn (sal) is the dominant species occurring in this region. The reserve covers a huge area of 3835.5189sq. km. and it falls in almost northern part of biogeographic zone of 6 and Biogeographic province 6a (Deccan peninsula, Central highlands). About 68.10% out of the total area of this reserves lies in the Bilaspur district in Chhattisgarh. The area of the Achanakmar-Amarkantak Biosphere Reserve is considered as one of the major watershed at peninsular India. It separates the rivers that drain in to the Arabian sea and Bay of Bengal. The reserve is also unique being the source of there major river systems like Narmada, Johilla and Sone of the Ganga basin.

Study area is described in detail by (EPCO,1999). The land use analysis made by RSAC, Bhopal indicates that 63. 19% of the area is occupied by the forests. It can be classified in to Northern tropical moist deciduous and southern dry mixed deciduous forests. The Reserve is rich in biodiversity, both flora and fauna and is also endowed with several rare and endangered species. It has rich diversity of medicinal and aromatic plants. However, increased biotic interference during the last two decades has eroded the structure and diversity of these forests. Major problems in the area are stray grazing by cattle, expansion of agriculture, increased mining, over exploitation of NTFPs and medicinal plants. The present study focuses on the relationship of environment to the composition, structure and diversity of forest communities of the Achanakmar-Amarkantak Biosphere Reserve.

MAP OF ACHANAKMAR–AMARKANTAK BIOSPHERE RESERVE

The climate of the reserve is tropical and the year is distinctly divisible in to winter (November- February), summer (April-June) and a warm rainy season (July-September), Mean monthly minimum temperature within the annual cycle ranges from 10.9^o to 25.6^{o}C and mean monthly maximum temperature from 24.1 to 42^{o}C. The annual rainfall average 1322mm. (mean monthly range is 6.63 mm to 359.88 mm) of which about 85% occurs during the period mid June to September.

The soil of the study area varies greatly depending upon the parent rocks and topography. Basically it is red lateritic, nutrient poor (lacking N and P) and characterized by excessive amounts of iron oxide

Survey

Based on the repeated reconnaissance of the area, three representative sites of size one ha in sole sal forest was selected for two growth strata e.g., upper story (trees) under story (saplings and seedlings). The forest vegetation was analyzed using 10 randomly placed quadrates (each 10 x10m) within the representative sites. The size and number of quadrates needed were determined using the species area curve (Misra, 1968) and the running mean method (Kershaw, 1973). In each quadrate,

Department of Forestry, Gurughasidas Vishwavidyalaya, Bilaspur,Chhattisagarh, INDIA
*Department of Forestry I.G.K.V. Raipur C.G. INDIA. Email:dixit1968@yahoo.com

dbh of each adult individual (>9.6 cm dbh) was measured. In the center of each 10 x 10 m quadrate, a 2 x 2 m area was marked for enumeration of saplings (individuals 3.2cm to < 9.6 cm dbh) and seedlings (individual < 3.2 cm diameter but < 30 cm height). In the present study the saplings and seedlings are pooled under the category of undestroyed vegetation. Stem diameter of adult and sapling individuals were measured at 1.37 m from the ground and for seedlings it was measured at 10 cm above the ground. The vegetation data were quantitatively analyzed for frequency, density and abundance (Curtis & Mclntosh, 1950). An importance value index (IVI) was calculated as the sum total of relative frequency, relative density and relative dominance (Phillips, 1959)

The alpha diversity and its components, i.e. species richness (Margalef index, 1958) and evenness (Whittaker index, 1972) were calculated for each plot. Beta diversity was calculated for each plot to represent the degree of habitat heterogeneity. These indices were calculated following Sagar and Singh (1999). Shannon-Wiener Index (1963) was used for species diversity.

H^1 = pi log pi-

where Pi is the proportion of basal cover/density of the species (ni) in the total of the community (N). We used a factor of 3.3219 to convert $\log_{10}$ to $\log_2$ (Smith 1974).

Concentration of dominance was measured by Simpson's index (Simpson 1949)

Cd = (Ni/N)2

where Ni and N are same as above.

Equitability (e) was calculated following pielou (1966), as:

E = H'/ S where H' = Shannon index and S = number of species.

Species richness (d) was calculated following Marglef (1958) as:

D = (S-1)/ N where S = total number of species and N - total basal cover/total density of all species.

Beta diversity was calculated according to the formula given by Whittaker (1972):

Bd = Sc/S

where Sc = total number of species in the two sites (i.e. sole sal forest site and degraded moist deciduous forest site) and

S = average member of species per site.

RESULT AND DISCUSSION

Species diversity

A total of 66 species belonging to 26 families were recorded from the study area. The results of data analysis reveals that the top canopy of the vegetation in the sal forests was dominated by *Shorea robusta, Pterocarpus marsupium. Terminalia tomentosa, Woodfordia fruiticosa and Diospyros melanoxylon*. The middle storey was found dominated by the *Miliusa tomentosa* and in the lower storey by saplings of *Diospyros melanoxylon* and *Shorea robusta* were observed to be predominant.

The density, basal cover and IVI for trees and under story layer are given in Table 1 and 2, respectively. The total basal cover of trees and Understory was 36.36 m^2ha^{-1} and 1.85 m^2ha^{-1}, respectively. The total density of trees and Understory was 1203 m^2ha^{-1} and 1572 m^2ha^{-1}, respectively.

Mean IVI of the dominant trees i.e. *Shorea robusta, Terminalia tomentosa and Diospyros melanoxylon* were 84.97, 37.43 and 24.84, respectively. In understory, the dominant species were *Miliusa tomentosa, Embelua robusta, Diospyros melanoxylon* and *Shorea robusta with* mean IVI of 47.72, 46.93, 45.39 and 38.09, respectively.

The complexity index is product of stem density, canopy height, number of species and basal cover (Holdrige *et al.*, 1971). For the present study the mean complexity index was 13.44, which could be compared to 5-45 for tropical dry forest and 180-405 for tropical wet forest (Murphy and Lugo 1986). This is in conformity to the report of Murphy and Lugo (1986) that dry tropical forests are less complex floristically and structurally than wet tropical forests.

Tree basal cover of sal forest is calculated as 36.36 m^2 ha^{-1} in the present study. This basal cover value was higher than that of the values reported for the several dry tropical forest communities in Vindhyan region by Jha and Sing (1990) between 6.58 - 23.21 m^2 ha^{-1} and by Singh and Singh (1991) between 3.84 to 10.36 m^2 ha^{-1}. These values could be compared with 17-40 m^2 ha^{-1} for dry tropical forest and 20-75 m^2 ha^{-1} for wet forest (Murphy and Lugo 1986). However the value of density, basal cover and IVI are in accordance to the earlier study of Agrawal *et al*, (2010).

Tree density of sal forest is 1203 stems ha^{-1} in the present study sites. However, density values in other ranges of Amarkantak regions were 845 - 980 trees m2 ha-1 for Karangia range,1,074 - 1,527 trees m2 ha^{-1} for Lamni range,19,12 trees m2 ha-1 for Lormi range, 934-1,912 trees m2 ha-1 for Kota range, 823-853 trees m2 ha-1 for Khudia range, 588-1159 trees m2 ha-1 for Pendra range, 782-1051 trees m2 ha-1 for Belgahna range, 964-1201 trees m2 ha-1 for Khodri range and 1269-1354 trees m2 ha-1 for Amarkantak range (EPCO,1999).

Density-GBH Relationship

Woody species density-GBH distribution followed non linear inverse relationships. The forest thus, exhibited a small structure with 44-47% individuals having < 10 cm GBH and 16-27% individuals having <50 cm GBH. Both the stands reflect uneven aged forest and a constant mortality or transition is noticed form one girth class to other (Fig-1).

The woody species density was related to GBH according to lny = 10.25-1.498 in *(r2 = 0.09, P<0.oo1) for sal forest site where y = number of individuals in Girth-class ha^{-1} and x= mid paint of the GBH. The density and basal cover values in the forest of Achankmar area are greater than the forests of Vindhyan hills and the forest of more dry climate. However, Rodgers (1990) reported a very high values of density (1352 stems/ha) and basal cover (131 m^2ha^{-1}) for the forest of Sariska Tiger Reserve.

Plant Diversity

Plant diversity parameters are summarized in Table-3. The higher concentration of dominance and rich diversity of sal forest could be related to uneven show of dominance i.e. in case of *Shorea robusta, Terminalia tomentosa* shows dominance was maximum as compared to other species. For the sal forest site, the species diversity (Shannon-Wiener index)for tree layer was 2.82, and for under story layer it was 2.93 as compared to Dry Dipterocarp Forest of Thailand (3.75-4.49) reported by Krratiprayon *et al.*(1995)and tropical rain forest of Silent Valley,

India (3.8-4.8: Singh *et al.*1984).

Diversity parameters in the tropical sal forest communities i.e., trees and understory vegetation are 2.82, 2.92 (Shannon-Wiener index), 0.99, 1.01 (equitability) 4.76, 2.32 (species richness), 0.21, 0.22(Concentration of Dominance) and 5.78,8.82 (Beta diversity), respectively. However, diversity parameters in tropical forest of the Vindhyan hill as reported by Singh and Singh (1991) had the range of 1.93-2.82 (Shanon-wienar index), 0.83-1.04 (equitability) and 0.18-0.39 (Simpson's index) 0.88-1.4 (species richness). Sager et al., (2003) also reported Shanon-wienar index between 1.398-2.629 for dry tropical forest located along the disturbance gradient.

Thus, the study reveals that the diversity and species composition of sole solesal forest is highly diverse. This also indicates that the climatic conditions of Chhattisgarh region would have been favorable for sal and its associates in the climax formation over a long successional process and have resulted into a highly diverse forests of sal. Therefore, the management plan should focus on sal and its associates in order to safeguard the overall diversity of the vegetation.

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Table 1: **Community structure of the tropical moist deciduous forest (tree layer)**

Species	Density (stems ha^{-1})	Basal cover (m^2 ha^{-1})	IVI
Adina cordifolica Benth & Hok. F. Rubiaceae	3.0	0.03	0.91
Anogeissus latifolia Wall.ex Bedd, Combretaceae	27.0	1.10	10.45
Bauhinia vahlii Wight & Arn. Caesalpiniaceae	3.0	0.02	0.88
Bauhinia malabarica Roxb. Caesalpiniaceae	7.0	0.07	2.12
Burseraceae	-	-	-
Buchanania lanan Spreng, Anacardiaceae	80.0	1.32	17.97
Bridelia squamosa Gehrm, Euphorbiaceae	7.0	0.12	2.26
Careya arborea Roxb. Lecythidaceae	7.0	0.62	2.86
Cassia fistula Linn. Caesalpiniaceae	3.00	0.02	0.88
Cordial dichotoma Forst. F. Boraginaceae	3.00	0.06	0.99
Dalbergia paniculata Roxb. Fabaceae	-	-	-
Diospyros melanoxylon Roxb. Ebenaceae	117	2.0	24.84
Dendrocalamus strictus Nees Poaceae	17.0	0.32	4.79
Embelia robusta C.B. Clarke non Roxb. Myrsinaceae	143.0	1.59	21.43
Eugenia cumini Druce, Myrtaceae	17.0	0.80	6.10
Emblica officinalis Gaertn, Euphorbiaceae	27.0	0.19	5.26
Ficus religiosa Linn. Moraceae	3.00	0.06	0.99
Grewia tiliacfolia Vahl., Tiliaceae	20.0	0.36	4.57
Kydia calycina Roxb. Malvacea	3.00	0.01	0.87
Lannea grandis Engl. Anacardeaceae	13.0	0.9	5.45
Lagerstroemia parviflora Roxb.	7.0	0.09	2.18
Madhuca indica J.F.Gmel. Sapotaceae	-	-	-
Miliusa tomentosa (Roxb.) J. Sinclair, Annonaceae	107.0	0.73	20.52
Mitragyna parvifolia (Roxb.) Korth, Rubiaceae	3.00	0.14	1.21
Ougeinia oojeinensis (Roxb.) HHHochr. Fabaceae	23.0	0.44	5.61
Pterocarpus marsupium Roxb. Fabaceae	40.0	3.31	18.78
Radermachera xylocarpa Roxb. K. Schum Bignoniaceae	10.0	0.50	4.12
Semecarpus anacardium Linn. F. Anacardiaceae	3.0	0.04	0.94
Shorea robusta Gaertn f. Dipterocarpacear	350	14.24	84.97
Terminalia tomentosa Wt & Agn. Combretaceae	140	4.98	37.43
Tectona grandis Linn. F. Verbenaceae	-	-	-
Terminalia chebula Retz. Combretaceae	3	0.31	1.69
Woodfordia fruticosa Lythraceae	10.0	1.73	6.17
Zizyphus xylopyra Willd, Rhamnaceae	7.0	0.26	2.64
Total	**1203**	**36.36**	

Table 2: **Species structure of the tropical moist deciduous forest (under storey layer)**

Species	Density (stems ha^{-1})	Basal cover (m^2 ha^{-1})	IVI
Aegle marmelos Correa ex. Roxb. Rutaceae	-	-	-
Anogeissus latifolia	7.0	0.001	1.15
Adina cordifolia	17.0	0.007	2.99
Bauhinia vahlaii	33.0	0.004	6.67
Buchanania lanzan	20.0	0.02	3.88
Boswellia serrata Roxb. Burseracae	-	-	-

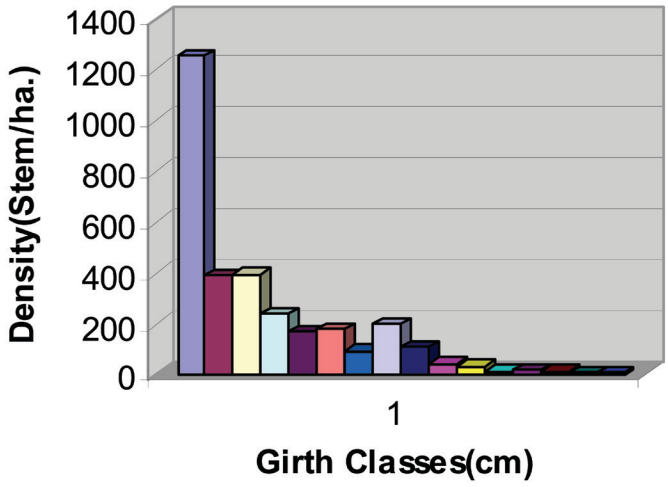
Cassia fistula	17.0	0.004	3.48
Dillenia aurea Sm. Dilleniaceae	3.0	0.0002	0.86
Diospyros melanoxylon	187.0	0.39	45.39
Embelia robusta	397.0	0.24	46.93
Emblica officinalis	23.0	0.05	8.52
Eugenia cumini	157.0	0.08	20.85
Gardenia turgida Roxb. Rubiaceae	3.0	0.0003	0.86
Garuga pinnata	-	-	-
Grewia tilifolia	40.0	0.05	8.07
Grevia hirsute vah. Tiliaceae	17.0	0.0004	2.63
Helicteres isora Linn. Sterculiaceae	13.0	0.0003	1.50
Heretic laevis Roxb. Boraginaceae	23.0	0.01	4.83
Indigofera pulchella Roxb. Fabaceae	10.0	0.003	1.45
Lagerstoemia parviflora	10.0	0.01	3.36
Madhuca indica	1.0	0.0004	2.19
Maliusa tomentosa	230.0	0.33	47.72
Ptcrocarpus marsupium	7.0	0.02	3.06
Radcrmachera xylocarpa	7.0	0.02	3.06
Randia uliginosa Dc. Ribiaceae	7.0	0.00007	1.10
Schleichera oleosa (Lour.) Oken, Sapindaceae	27.0	0.008	5.90
Semecarpus anacardium	30.0	0.007	1.22
Shorea robusta	247.0	0.16	38.09
Smilex macrophylla Roxb. Liliaceae	7.0	0.0007	2.02
Terminalia tomentosa	10.0	0.03	3.79
Terminalia chebula	7.0		1.48
Tectona grandis	-	-	-
Ventillago calyculata Tul. Rhamnaceae	30.0	0.39	25.82
Wendlandia exserta Dc. Rubiaceae	-	-	-
Ziziphus xylopyra	30.0	0.007	1.22
Ziziphus ocnoplia Mill. Rhamnaceae	-	-	-
Total	**1572**	**1.85**	

Note : All data are average of three plots

Table 3: **Diversity parameters of Sal dominated and degraded moist deciduous forest**

Parameters	Tree layer	Understorey vegetation
Species richness (d)	4.76	2.32
Shannon – Wiener index	2.82	2.92
Concentration of dominance (Cd)	0.21	0.22
Equitability (e)	0.99	1.01
Beta diversity (Bd)	5.78	8.82
Number of species per 0.1 ha	30	30

Relationship Between Density and Mean Girth



Protected Areas Management in Odisha - An Institutional Approach

Brajaraja Mishra *

I. INTRODUCTION

IUCN defines Protected Areas (PAs) as, "an area of land and/ or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resource, and managed through legal or other effective means, are the cornerstone of the global community's efforts to conserve biological diversity" (Scherl et al. 2004). According to the '2003 UN List of Protected Areas', about 17.1 million square km of the (11.5% of the land surface) earth's surface and 1.7 million sq km of marine ecosystem are covered by PAs (Chape et al. 2003). These are categorized into six: Strict Nature Reserve/Wilderness Area, National Parks, Natural Monument, Habitat/Species Management Area, Protected Landscape/ Seascape, and Managed Resource Protected Areas which are declared with different objectives, varying degrees of restriction and level of protection. The first four categories are strict PAs and only the last two categories show the linkage with human society. These ecosystems are providing numerous social, economic and ecological benefits to the communities (Leverington et al., 2010) and are categorized into four types: provisioning (e.g. food, fuel wood, fresh water, and herbal medicines); regulating (e.g. climate regulation, watershed protection, coastal protection, water purification, carbon sequestration, and pollination); cultural religious values, tourism, (education, and cultural heritage); and supporting (soil formation, nutrient cycling and primary production) (IUCN, 1992; MEA, 2003).

In the earlier period, Command and Control (C&C) measures were adopted by respective state governments to manage these PAs to maintain their ecological viability by restricting human interventions. This management regime does not recognise any types of societal linkage towards ecosystem conservation. It did not provide any immediate concrete poverty relief and security for communities in and around the protected areas (McNeely, 2004; Naughton-Treves, 2005). As a result the opportunity costs of protection were increased which exacerbate and perpetuate poverty. Strict PAs involves displacement of people, deprived them to access resources, and denied indigenous communities to enjoy their traditional rights and responsibilities (Lewis and Carter, 1993; Ghimire and Pimbert, 1997; Brechin et al., 2003). There is also possibility of crop-raiding and live and livestock killing by herbivores and predators (Upreti, 1985). Crop depredation is a serious problem for those who depend heavily on agriculture for their survival (Kharel, 1997). It also carries a high social component in terms of time and labour expended. For example school going children are involved in crop raiding, migration of entire family due to several crop losses, physical insecurity caused by wild animals and etc. (Biryahwaho, 2002). It poses severe threat to survival of PAs due illegal collection of resources, poaching, and encroachment by agricultural and pastoral communities.

For instances, villages living near Bhadra Tiger Reserve are losing 12% of livestock per year (Madhusudan, 2003); Sariska Tiger Reserve experienced 27% of harvest loss due to wild population (Sekhar, 1998); Kibber Wildlife Sanctuary (WLS) suffered 18% of livestock loss costing $128 USD to each family (Mishra, 1997); Kyona Wildlife Sanctuary experienced Rs. 2.13 lakh worth of livestock loss within two years (Bokil, 1999). Human causalities due to wildlife attack also shows same picture: in Bihar 242 causalities by elephants within five year (Rajpurohit, 1999); each year Sunderbans experiences 36-100 causalities due to tiger (Macdonald and Sillero-Zubiri, 2002); 67% causalities by sloth bear within five years in Madhya Pradesh (Rajpurohit and Krausman, 2000); 193 attacks by Gir lion during 1973-91 in Gujarat (Saberwal et al., 1994).

Growing miseries and poverty forced these people to act against the protection of the ecosystem. As a result many PAs were experienced several threats in terms of poaching, forest fire, irregular cutting of timber, huge exploitation of forest resource and etc. which gone against the sustainable ecosystem management principles. Policy makers recognized that it not the keeping away of the communities from the management decisions but to accept their interdependency which can make the management objectives successful. As a result worldwide steps are undertaken to develop a new approach to ecosystem management by incorporating poverty into the decision making process. Various country specific approaches were developed to achieve ecological sustainability by reducing poverty of the poor.

Under this background the main aim of this study is to explore various PAs management regimes and their effectiveness to conservation of ecosystem by reducing poverty. The second section explains some of the institutional issues and management

* Research Unit for Livelihoods and Natural Resource, Centre for Economic and Social Studies, N.O Campus, Begumpet, Hyderabad-500016.
email: mishrabrajaraja@gmail.com

principles evolved worldwide in the area of protected ecosystem conservation by recognizing interdependence with welfare of the communities. Development of various management principles and policy in case of India with a particular reference to Odisha is explained in the third section. Fourth section explores livelihood and ecological impact of various management regimes in various PAs of Odisha and the last section is about summary and conclusion of the study.

II. PROTECTED AREAS MANAGEMENT: INSTITUTIONAL ISSUES

Establishment of PAs does not necessarily guarantee protection of biodiversity, environmental or cultural features that it contains (Stolton et al., 2007). Thus it is widely felt that PAs can only deliver their services if they are effectively managed (Dudley et al., 2010). Effectiveness assumes that management should be tailored to the particular demands of the site which requires adopting appropriate management objectives and governance systems, adequate and appropriate resourcing and timely implementation of appropriate management strategies and process (Hockings, 2006). There is a symbiotic relationship between the PAs and poverty and understanding the linkage is a practical and ethical necessity (Scherl et al., 2004). It is practical because PAs are significantly contributing towards sustainable development and other types of land use. And it is ethical because human rights must be realized on the ground of social justice. Thus biodiversity conservation and sustainable use of resources need to be reconciled at the local level with livelihood opportunities and empowerment of the poor.

The Bali Action Plan (1982), Third World Parks Congress recommended that to increase area of total PAs about 10% of country's geographical area and people can contribute towards successful PAs management if rights are to be given communities to share resources (McNeely and Miller, 1984; Naughton-Treves, 2005). Participants in the Fourth World Park Congress agreed in the Caracas Declaration that management of protected areas "must be carried out in a manner sensitive to the needs and concerns of local people", and encouraged "communities, non-governmental organizations, and private sector institutions to participate actively in the establishment and management of national parks and protected areas" (McNeely, 1993). They called all governments to integrate planning for the PAs with programmes for the sustainable development of the local cultures and local economies by enhancing local knowledge and decision-making mechanisms. A formal international commitment has come in the 1992 UN Conference on Environment and development (Rio Earth Summit) where about 179 governments signed an agreement well known as Convention on Biological Diversity (CBD) for conservation of biological diversity, sustainable use of the components of biological diversity, fair and equitable sharing of the benefits arising out of the utilization of genetic resources. The Fifth World Park Congress (2003) held in Durban, South Africa has given various recommendations relevant to its theme 'Benefits Beyond Boundaries', on poverty and PAs. The Millennium Development Goals also widely accepted the interdependence of human welfare and conservation of natural resources.

As a result, starting the focus on exclusion of people from the PAs, there is wide recognition of the fundamental linkage between natural resources, people and culture (Phillips, 2002). If one juxtaposes the conventional and emerging approach to PAs management, a change of perspectives occurs that has levelled a

Table No 1: **A Paradigm Shift in Protected Areas Management**

The conventional understanding of protected areas	The emerging understanding of protected areas
Established as separate units	Planned as part of national, regional and international systems
Managed as "islands"	Managed as elements of networks (protected areas connected by "corridors", "stepping stones" and biodiversity-friendly and land uses)
Managed reactively, within a short timescale, with little to lessons from experience	Managed adaptively, on a long time perspective, taking advantage of on-going learning
About protection of existing natural and landscape assets-not about the restoration of lost values	About protected but also restoration and rehabilitation, so that lost or eroded values can be recovered
Set up and run for conservation (not for productive use) and scenic protection (not ecosystem functioning)	Setup and run for conservation but also scientific, socio-economic (including the maintenance of ecosystem services) and cultural objectives
Established in a technocratic way	Established as a political act, requiring sensitivity consultations and astute judgement
Managed by natural scientist and natural resource experts	Managed by multi-skilled individuals, including some with social skills
Established and managed as a means to control the activities of local people, without regard to their needs and without their involvement	Managed by multi-skilled individuals, including some with social skills

Established and managed as a means to control the activities of local people, without regard to their needs and without their involvement	Established and run with, for, and in some cases by local people; sensitive to the concerns of local communities
Run by central government	Run by many partners, including different tiers of government, local communities, indigenous groups, the private sector, NGOs and others
Paid for by taxpayers	Paid for from many sources and, as possible, self sustaining
Benefits of conservation assumed as self-evident	Benefits of conservation evaluated and quantified
Benefiting primarily visitors and tourists	Benefiting primarily the local communities who assume the opportunity costs of conservation
Viewed as an asset for which national considerations prevail over the local ones	Viewed as a community heritage as well as a national asset

Sources: Borrini-Feyerabend et al. (2004)

"paradigm shift" (Borrini-Feyerabend, 2004) (Table 1).

Two important issues emerge by a paradigm shift in the management system in case of PAs: equity and property rights.

Equity

There is wide concern about the social equity in conservation which is based on the notions of ethics and morality. The conventional approach to protection of PAs by completely restricting human intervention has experienced many conflicts in the society. It increased poverty and inequality in the society by reducing consumption and income. Poor and marginal people are forced to relocate some areas with inadequate food and employment opportunities, less fertile land holdings, and improper shelter facilities. They also forced to transfer their land holdings at a negligible price and are unable to get even the same quantity of land in other places. Lack of proper skill and education prevent them to engage in other jobs rather than their traditional livelihood activities. But the new approach put some obligation to embrace equity in the mission to encourage and assist societies throughout the world to conserve the integrity and diversity of nature by ensuring equitable and ecologically sustainable use of natural resources. IUCN and UNEP in 1991 recommended involvement of local people in establishing and reviewing national PAs policy; in design, management and operation of individual PAs; sustainable economic returns from the PAs supported by the local communities; and PAs management by local communities (Borrini-Feyerabend et al., 2004).

Property rights

Over the past few decades, conservationists primarily in developing countries began working with local communities to make economic development feasible to manage these resources. It started with the UN Declaration of Human Rights in 1948. Since then a lot of agreements and obligations have came for the vulnerable and poor on the ground of human rights. Ethical principles and values set rights to achieve a minimum standard of life as human rights. These rights represent the ideal that governments strive for in providing for their citizens - basic life requirements that all humans are entitled to. The International Covenant on Economic, Social and Cultural Rights, 1966 introduced human rights processes ranging from monitoring procedure to global summit and requested governments to implement these provisions. In this summit, rights of indigenous people have emerged as a part of human rights. The ILO Convention, 1989 also recognized rights of the indigenous people by recognizing their social, cultural, spiritual and religious values and practices (Borrini-Feyerabend et al., 2004). Accordingly, indigenous people should participate in the use, management and conservation of renewable and non-renewable natural resource and people should not remove from the land they occupy. If relocation is a necessary it should assure rights with adequate compensation.

Various international conventions and provisions also came in the history of conservation of natural resources with respect to the equity and rights of indigenous and local communities. For instances: Ramsar Convention recognizes long-standing rights, ancestral values, and traditional knowledge of indigenous people and institutions associated with their use of wetlands (Borrini-Feyerabend et al., 2004). CBD advocates respecting, preserving and maintaining knowledge, innovations and practices of indigenous local communities with respect to the conservation and sustainable use of biological diversity and encourages the equitable sharing of benefits arising from the utilisation of such knowledge, innovations and practices.

IUCN recommends that, communities should be encouraged and assisted by governments to develop local strategies with environment priorities and get enough scope to convert these strategies into action. As a result many IUCN Resolutions and Policy Documents recognized community rights over the land and resource access, ownership, participation in decision-making, tenure security and sustainable use. WCC Resolution 1.53 also advises members to recognise indigenous rights in conservation, to establish co-management agreements and secure equitable benefit sharing. The policy statement of IUCN and WWF states that (Borrini-Feyerabend et al., 2004), "indigenous and other traditional people have long associations with nature.... They maintain most of the earth's fragile ecosystems and there is proper co-existence between the two.... As such conservationist and policy

makers should work in the area of effective PAs management, by respecting rights of the traditional forest dwellers to sustainable use of their lands, territories, waters, coastal seas and other resources.... At the same time indigenous people should recognise their responsibility to conserve biodiversity, ecological integrity and natural harboured in the protected areas.... The principles of decentralization, participation, transparency and accountability should be taken into account in all matters pertaining to the mutual interests of PAs and indigenous and other traditional peoples.... Indigenous and other traditional people should be able to share fully and equitably in the benefits associated with PAs".

Not only rights communities should have to endow with responsibilities. Thus, Resolution 1.44 on Public Access (Montreal, 1996), IUCN stresses that "the needs of conservation, management, ownership, safety and security may well require some limits on public access to land". Management Category Guidelines (1994) and Principles and guidelines for Indigenous Area Management Category Guidelines for Indigenous and Traditional Peoples and Protected Areas (2000) also explains similar propositions. As such some resources should keep untouched for the purpose of maintenance of viability of the ecosystem. Sometime on the feasibility ground it is difficult on the part of the policy makers or other institutes to fulfil every demand of every person in the society. On the ethical ground also it is difficult on the part of a government to fulfil all the claims of all persons (Griffin, 2000).

Johnston (1995) rightly points out that humanity faces deprivation from environment rights because of at least three grounds: firstly, some people are living in the wrong place (near to mining areas, weapon testing place, storage of hazardous waste, boarders between two political regions etc.). Some one or more reason these are displaces, alienated from their traditional holdings, and experiencing increasing difficulty in maintaining individual, household, and community health (Cultural Survival, 1993; Burger, 1987). Secondly, some time people are in the way of progress and national needs supersede individual and community concerns. Thus, people find themselves forcibly relocated while governments and industry build dams, expand export-oriented intensive agriculture, develop international tourist facilities, and set aside "wilderness "to save the bio-commons and attract ecotourism (The Ecologist, 1993). Lastly, some time it is socially, culturally, and legally acceptable to protect the health of some people, while knowingly placing other humans at risk (Johnston and Dawson, 1994; Johnston and Button, 1994). Thus there is a need for trade-off between the rights and duties. For effective conservation, there is necessity of assignment of fair and effective responsibilities including restrictions in resource access by maintaining overall rights based approach (Borrini-Feyerabend et al., 2004).

History of protected areas management policy in India also experienced this paradigm shift. There is a wider shift in management policy from the state regulations through the Indian Wildlife Protection Act, 1972 to recent development of Eco-Development Committee (EDC) and Forest Rights Act (FRA), 2006. This paradigm shift in management policy with respect to the Protected Areas is explained here with special reference to the state of Odisha.

III. HISTORY OF PROTECTED AREAS MANAGEMENT APPROACHES

Odisha is one of the few states in India which contains largest proportion of forest areas. Government of Odisha adopted the Wildlife (Protection) Act (WLPA), 1972 on August 1974. Currently Protected Area Network (PAN) of Odisha comprises of one National Park (Bhitarkanika), eighteen wildlife sanctuaries, and one proposed National Park which covers about 4.2% (6611.12 sq km) of the geographical area and 11.2% of the total forest area of the state (DoEF, Odisha).

a. The Wildlife (Protection) Rule, 1974

It has come into force during 1974 followed by the Wildlife (Protection) Act, 1972. Under this central government is the solely responsible for the demarcation, conservation, and protection of the ecosystem. There is no such provision undertaken for inclusion of indigenous people in the management process. There is strict prohibition for wilfully pick, uproot, damage, destroy, acquire, collect, process, sell or transfer of any specific plants; and trade or commerce of wild animals, any animal particulars and trophies. People are also restricted of collection and processing of forest produces and engagement of any livelihood activities that will create any harm to existing wildlife. However a person can enter into the sanctuary if he has some immovable properties such as houses, agricultural lands, etc. inside the sanctuary. But in case of National Park, there is no such provision on the ground that all people in these areas were relocated with adequate compensation. Fishing is allowed to communities after proper verification that it is their main livelihood activity. Accordingly, short term licences are provided for regular entry and doing fishing activities. But no person is allowed to use set nets or any other kind of nets made of yarn, or nylon other than angling, throw net and floating baits. Use of large baited hooks and chemicals, explosives, poison and poisoned bait, poisoned weapon, artificial lights, or mechanized boars are strictly prohibited. Provisions are also made in this Act regarding compensation of live or livestock loss or crop loss by wildlife. Persons living inside the PAs have to provide certain responsibilities such as to report death and safeguarding of any wild animal until arrival of the authorised officers; to prevent fire; not to carry any arms or explosives or any other injurious chemicals; to protect demarcated boundary; to prevent from molestation and teasing of wild animals; and prevent from littering the ground.

b. Eco-Development Programme

Eco-Development Committee (EDC) as a strategy for sustainable conservation of biodiversity in the PAs adopted in Odisha during 2006, by recognizing the symbiotic relationship between people and ecosystem. It was started as a pilot project in Satkosia Tiger Reserve and then extended to other PAs like Bhitarkanika, Kotagarh, Kuldiha and Lakhri Valley Wildlife Sanctuary (Green et al., 2010). Under this system, opportunities are provided to local communities, NGOs, and technical institutions to contribute in the eco-development programme by participating various stages of the programme: planning, implementation and monitoring. Hence, the outlined objectives of the EDC are: to intervene in the life styles of people by

providing alternative means of livelihoods such as eco-tourism; to reduce conflict between wildlife and human beings; enhance people's participation in biodiversity conservation; to improve management capabilities and enhancement in protection; and adoption of load use practice compatible with the objectives of biodiversity conservation. Thus it provides a strong linkage between the conservation and development by providing alternative livelihood activities like eco-tourism, off-firm activities, and local biomass dependence. According to the micro planning some villages are selected for piloting eco-development in the buffer areas, so that it is possible to maintain integrity of the core area. The principal tools used under this system include social mapping, visioning, forest dependency, wellness ranking, and household interview.

The detail procedure as Green et al (2010) mentions, a range of eco-development activities, specific to a particular area are then identified and funds are allocated for over all development. Entry point activities are identified and prioritized by villagers at the beginning of the participatory planning process so that community ownership and benefits should cover majority of the households. There are some common interest activities relevant to the entire village but may require more investments or falls in purview of the other agency can be approached to address the entry point activities. Income generation activities are targeted at household levels based on forest dependence and wellness ranks which benefits people and helps to reduce forest dependency. Activities such as self-help groups (SHGs), community based eco-tourism, etc. may promoted as alternative livelihoods activities. As a rewards to these activities, local communities have to assure to provide certain responsibilities: no fire, poaching, illegal felling of timber or encroachment in village forests or any other forests; no grazing in the plantation areas; provision of intelligence, information and other assistance in the prevention and investigation or offences and offenders; 100% immunization of livestock; and registration of all fire arms in the village. In return to these duties EDC members may granted: rotational grazing of livestock inside the sanctuary; rotational collection of fuel woods; regulated collection of non-timber forest produces (NTFPs) for self-consumption; and regulated collection of bamboo.

c. The Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006

This Act recognizes and vests rights over the forest land of the schedule tribe and other forest dwellers who are residing in these areas for generations. It includes responsibilities and authority for sustainable use, conservation of biodiversity and maintenance of ecological balance and there by strengthening the conservation regime of the forests by ensuring livelihood and food security to forest dwelling scheduled tribes (STs) and providing other traditional forest dwellers, including those who were forced to relocate their dwellings due to state intervention. Thus, the underlying objective of the Act has been to strike a balance between the potentially conflicting interests of the forest dwelling communities and protecting forests and wildlife resources (FRA 2006).

Under this Act, various rights are provided to secure both individual and community tenure rights over the forest land: rights to hold and live in the forest land under the individual and common occupation for habitation or for self-cultivation for livelihood; right of ownership, access to collect, use, and dispose of NTFPs, community rights of uses or entitlements over fish and other products of water bodies, and grazing lands; community tenure rights of habitation; rights over dispute lands; rights of settlement and conversion of all forest villages; rights to protect, regenerate or conserve or manage any community forest resource; rights to access to biodiversity and community rights to intellectual property and traditional knowledge related to biodiversity and cultural diversity; and rights to in situ rehabilitation including alternative land.

There is also provision to declare critical wildlife habitats in the PAs which is necessary to maintain wilderness of the area for the purpose of conservation of certain endanger species. In order to enjoy these rights these people are empowered to: protect the wildlife, forest and biodiversity; ensure protection of adjoining catchment area, water bodies and other ecological sensitive areas; ensure to preserve habitat of forest dwellers from any form of destructive practices affecting their cultural and natural heritage; and ensure to regulate and stop any activity which adversely affects wild animals, forests and the biodiversity. Clear provisions are also undertaken active participation of these persons with adequate gender equality in various stages of the decision making process with respect to the claims over the rights to access these resource and conservation of biodiversity.

From the above it is clear that government of India has taken ample steps for conservation of PAs by recognizing the interdependence with poverty reduction goal. Following the global development of the idea of inclusion of forest dwellers in the management process, there is a paradigm shift in the management process from state regulations with strict restriction of use of resources to a participatory approach to conservation by ensuring livelihood. However, the effectiveness of management process is still a question mark due to the persistent of poverty among the forest communities and concerned ecosystem degradation. It needs to analyze effectiveness of the history of the management process to understand loopholes in the management process to ensure livelihood and ecosystem conservation. The next section explains various livelihood and conservation issues of PAs of Odisha based on literature in a chronological order of their publication to justify management effectiveness of protected areas.

IV. Livelihood and Ecological Impacts

More than three lakh people[1] are residing inside the PAs of Odisha and earn a subsistence level of livelihood from these ecosystems in terms of agriculture, fishery, NTFRs, and etc. Implementation of the Wild Life Protection Rule (WLPR) (1974) suddenly imposed restrictions on collection and processing of NTFRs, grazing of cattle, and collection of fuel. Vasundhara (2004) had made an assessment of livelihood loss in Satakosiya Wildlife Sanctuary after restrictions of livelihood activities in the sanctuary areas. This study points outs that before protection, household's have a substantial amount of income of Rs 5000

[1] These figures are based on census 1991 and 1981. The actual populations living inside the protected areas are more than the mentioned amount.

which come from various sources like bamboo trading, collection of Kendu leaf, Sal leaf, Mushroom, wage labour and agriculture. But immediately after restriction this income reduced to Rs 2,250 and derive from various sources like daily wage, illegal trading of Sal and Kendu leafs, and agriculture. Some of the households particularly children were working as bonded labour in the near village/town. Government also not recognized community rights over those lands which are used for shifting cultivation (5,000-37,000 sq km). Persistence of poverty and deprivation due to restriction of resources created agony and revolt against the government. For instance about 25,000 of fisherman voiced against a ban on fishing to protect Olive Ridley Turtles in the Gahirmatha Wildlife Sanctuary. They are of the opinion that conservation should not cost livelihood options of the poor and they are using traditional way of fishing which does not affects free movement of turtles. It also created opportunity cost in terms of closing of ice-producing and boat-making industries.

In some areas like Bhitarkanika, Chandaka and Similipal, people were relocated in order to reduce anthropogenic pressure and human-animal conflicts. But it failed to relocate all the households from the sanctuary area. For instance, out of 483 in Chandaka Wildlife Sanctuary, only 85 households were resettled within a decade (1994-2004) (Vasundhara, 2004). Those households who were voluntarily resettled due to flavorous promises given by government to provide facilities like cash compensation, housing, drinking water, fertile land, schooling and etc. faced several problems due to paucity of funds. Barren lands were distributed to some habitats but these people who previously earned a substantial part of income from vegetation now unable to cultivate. In latter period forest department again reoccupied those lands for plantation. Amidst these strict restrictions several instances show that communities have helped to the government departments in mangrove regeneration near Bhitarkanika WLS; protected wildlife of Similipal WLS from killing by indigenous tribals.

One important point here to be noted that PAs were faced several threats (Kalpavriksh, 2005) from encouragement of growing economic activities like ports (e.g. Bhitarkanika WLS), industrialization (e.g. Bhitarkanika WLS), mining (e.g. Karlapet WLS); illegal settlements by Bangladeshi immigrants (e.g. Bhitarkanika and Debrigarh WLS); commercialisation of forest resource (Balukhand-Konark WLS); pest and weed (e.g. Similipal and Chandaka WLS); and forest fire (e.g. Bhitarkanika WLS). But ignorance to these drivers of change in ecosystem caused increased food scarcity, habitation change and death of the animals. It also increased human-animal conflicts. So this period experienced death of several wild animals mainly due to poaching.

Thus there was a wide thinking between the policy makers to conserve these PAs by extending their help towards poverty elimination by creating alternative livelihoods opportunities so that communities can reduce their dependency over the forest resources. Activities like eco-tourism, awareness programmes about importance of ecosystem to welfare of people and NREGS programmes are implemented in these PAs. For instances (Kalpavriksh, 2006): Similipal Tourism Development Project worth of Rs 10 crore was started in Similipal WLS with help of the central government for promotion of the community tourism activities. Odisha government also invested a lump sum amount of Rs 12 crore in each Bhitarkanika and Satakoshia sanctuary. Activities like construction of several watch towers, log and bamboo cottages and other related amenities were also undertaken.

The Sandhan Foundation in conjunction with the UNEP-GPA, NC-IUCNTRP, MAP-USA and Government of Odisha had initiated a project for Coastal Community Centre (CCRC) in Bhitarkanika WLS with the objectives of to educate the local population about the importance of wise management of the mangrove forest for improvement of their health, protection from the effects of climate change, and to achieve sustainable development (Kalpavriksh, 2007). It has undertaken various alternative livelihoods creation opportunities like: research into alternative crops and firewood able to grow in saline conditions, aquaculture in tidal ponds outside the sanctuary, collection of cow-patties or purchase of biomass/solar cooking equipment, green fencing and increased education and development of artistry to provide flexible sources of income and increase human capital. The Centre is also serving as a rest house for scientist and tourists as a part of the promotion of ecotourism, providing local people yet another possible source of income, and increasing the demand for a well-developed transportation network.

NREGS activities are undertaken in these WLS. For instance about 20000 tribals of Satkosia WLS are benefited by NREGS (Kalpavriksh, 2007). It has served as a safety net programme against the livelihood risks and food scarcity faced by these people due to restrictions imposed followed by the Supreme Court orders in 2000. These activities somehow succeeded to improve welfare of people and there by reduction in livelihood dependency on forest. A study by Anthropological Survey of India has claimed that some villages inside the Similipal WLS remain undisturbed (Kalpavriksh, 2007). Constructing a disturbance index (DI) this study shows the percentage of damaged trees to total number of trees per 2000 sq. km. is less than 20 percent. There are also instances where people voluntarily taken initiatives to conserve the PAs such as some residences of Bhitarkanika WLS were donated about 500 hectares of their ancestral lands to the Forest Department for mangrove regeneration (Kalpavriksh, 2007). People in Badrama WLS have lodged a complaint in Odisha High Court regarding growing forest cutting by timber mafias and inefficiency of the forest department to control them. But experiences also show that there were continuation of poaching, illegal fishing activities and forest fires for collection honey and wax in most of the WLS.

As such government recognized that it is not the creation of the livelihood opportunities but provision of security against livelihood risks and food insecurity that can be able to achieve sustainable growth of the PAs. Odisha is one of the pioneering states for implementation of FRA, 2006 in the PAs. People are getting benefits out of them which motivated them to conserve the ecosystems. For instance, villagers of Karlapat WLS are protecting forest ecosystem after claiming their rights under the FRA, 2006 (Kalpavriksh, 2008). Women in some time back were unable to curb timber mafias have seized three truck loads of timber from the official residence of the Range Officer in charge of the sanctuary. Some villages that in some time were encroached villages are now successfully protecting the area from forest fire. One community complained to Ministry of Environment and

Forest against the DFO who was denied to lift river sand for the construction of a school.

However, communities in most of the PAs are deprived of enjoying various rights under FRA (Kalpavriksh, 2010). For instances, members of the committee appointed by the Ministry of Environment and Forest and Ministry of Tribal Affairs to look into the implementation of the FRA in Similipal WLS in July, 2010. According to this report, this programme was started vary late and most of the people are not aware of the FRA. No verifications have been carried out due to moist fear and people were told not to claim lands except agricultural lands. Most of the CFR forms were filled by forest officials themselves where many rights were violated e.g. denying firewood and nistar rights, not mentioning the right to manage and protect forest, not giving the area of the forest in which MFP rights are applicable. Some people are also claiming that revenue inspector has demanded bribe for the land verification. Information about staying in the core areas according to this Act also did not provided to those people who are not interested to relocate according to their will. Those who were relocated suffered by lake of water, poor quality of land, absence of pattas, shortage of land, inadequacy of fuel and fodder source nearby, and broken promises of various kinds in the new places. However, these people received pucca houses, and benefits under NREGS and ration card.

V. CONCLUSION

This study explains about a paradigm shift in the management of PAs in recent years and the responses of international institutions to this change. The idea of strict restrictions over the resource use by undermining co-existence over a long period of time deteriorated the forest ecosystem. It caused damages to wildlife and forest by raising conflicts and agony among the communities due to their growing deprivation and vulnerability. Policy makers thus recognized the interdependence between poverty of the poor and management of PAs and adopted participatory approaches on the ground of human rights and social justice. India as a part of this global policy, introduced various programmes by inviting communities into the management process. As a result, there is a remarkable change in welfare of the communities which created incentives for effective management of PAs. But at the same time conflicts over resource use because of either poverty & vulnerability of the communities or negligence of policy put hurdles on the way of effective management. But it should not mean that these programmes are failed totally to tackle the problem. In some way these measures were improved welfare by creating or security livelihoods opportunities and as such remarkable improvements in forest restoration. There is also significant decline in human-animal conflicts. As recent experience shows that total number of tiger population has increased from 173 in 2002 Census to 192 in 2006 Census. But no such human causalities or livestock depredation so far reported from these WLS who at some time past experienced several conflicts. It is not the enactment of new programmes but their effective implementation that can make management policy successful. Thus there is immediate need to force management stakeholders to work rigorously to achieve target oriented goals.

Secondly, various welfare programmes are going on in these areas like Targeted Public Distribution System (PDS), Integrated Child Development Scheme (ICDS), Mid Day Meal Scheme (MDM), Swarnajayanti Gram Swarozagar Yojana (SJGSY), Joint Forest Management (JFM), etc. The main aim and objectives of these schemes are more or less same. Most of these programmes became ineffective to improve livelihoods, nutrient, health and sanitation status of the people living inside the forest areas. Except all other factors, paucity of funds and lack of human resources two important factors of ineffectiveness. Convergence of these programmes with forest management programmes (e.g. convergence of NREGA with land development programmes) can reduce high transaction costs in terms of human resources, time and ambiguities in the implementation process.

Thirdly, ignorance of communities about ongoing programmes, their areas of operation, opportunities and constraints, and outcomes are some of the other factors which reduce their noble intention of forest conservation. As this study has highlighted rights over the resource use empowered communities to protest against falling of trees by timber mafias inside the PAs. It is also mentioned that ignorance about rights of habitation created panic and depression to those people who were forcefully relocated. Thus dissemination of knowledge about various programmes is a prerequisite for effective management.

Fourthly, there is need for change in relationship between the forest officials and communities. While forest people are thinking communities are the main destroyer of forest, communities have the perception that forest people are care-taker of the forest. The continuous conflicts between these two stakeholders' in terms of protests against decision about restrictions of resource use, regular attacks to forest officials, and harassments to local people by forest people creates an environment of destitute and agony which ends with degradation of the forest ecosystem.

Fifthly, illegal exploitation of forest products to maintain minimum basic needs of life shows that poor are socially and economically deprived-off in the society. Alternative livelihood opportunities should thus benefit most of the poor in the society. Most of the community-oriented programmes like ecotourism, SHGs, etc., are unable to catch the intra-household inequalities. As a result, some socially privileged people in the same community became better-off at the cost of poor. There is also possibilities of dominance of these people in the decision making process. Insecurity and powerlessness of these deprived poor reduces his attitude toward forest protection.

Lastly, all programmes and activities should not divert from the ultimate aim of ecosystem conservation. All welfare activities should not run by creating harmful effects to ecosystem. All stakeholders should recognise importance of healthy ecosystems and associated ecological and societal impact. Thus policy makers should became flexible during the decision making process; and communities must have to take care about the ecological viability of the system during livelihoods activities process.

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Desperate Neighbours? Understanding and Alleviating Conflict Between Endangered Species and the Rural Poor

M. D. Madhusudan *

THE GENESIS OF CONFLICT

Wildlife conservation in India is hinged on a legally established system of *protected areas* within which conserving endangered/ threatened species and sustaining ecological processes are meant to take priority over competing social concerns (Karanth 1998). Around nearly every protected areas in the country are *production areas* that are harnessed to achieve social goals that range all the way from supporting basic livelihoods and human development, to driving wealth creation and macroeconomic growth.

Yet, it is quite common that wildlife—even endangered species—continue to occur in or use production areas for their survival, while human communities continue to live in and utilise protected areas for their livelihood (Madhusudan and Rangarajan 2010). The inevitable outcome of such spatial overlap—of wildlife in *production areas* and people in *protected areas*—is conflict between people and wildlife. Such conflicts chiefly manifest in two distinct forms. The first form of conflict, which I term *human-wildlife conflict*, is over the undesired use of production areas by wildlife, whereas the second, which I term *natural-resource conflict* results from the undesired use of protected areas by people.

Both human-wildlife conflict as well as natural resource conflicts have been treated as important in the context of PA management in India and efforts have consistently been made to reduce these conflicts (Karanth et al. 2002). Human wildlife conflicts have customarily been dealt with using physical barriers, financial compensations and, rarely, through insurance. On the other hand, natural resource conflicts have been dealt with through the use of legal/physical barriers as well as through the use of financial/social penalties (Madhusudan and Raman 2003). However, considering the widespread increase in both these conflicts in recent times, it would seem that these measures have been neither effective nor enduring in tackling either form of conflict. Why is this so, and how indeed can such conflicts be reduced? In my talk, I examine how these forms of conflict are related, and discuss how the understanding of their relationship can inform and advance our ability to alleviate conflicts and better reconcile the priorities of protected areas with the production areas that surround them.

MAKING GOOD NEIGHBOURS: A CASE STUDY FROM BANDIPUR TIGER RESERVE

Bandipur is a National Park and Tiger Reserve in the southern Indian state of Karnataka, established in 1973 and encompassing a tract of dry deciduous forests stretching over 880 km^2. Bandipur is part of the Nilgiris-Eastern Ghats landscape, which is thought to be one of the largest populations globally for endangered large mammals including the tiger, Asian elephant, gaur and dhole. On Bandipur's northern flank are over 180 villages, whose residents are mostly peasants reliant on rain-fed agriculture and cattle-rearing. This agricultural tract is part of Chamarajanagar district, which ranks 25th among Karnataka's 27 districts in terms of its human development index. These villagers have historically carried out a range of economically significant activities involving natural resource extraction within Bandipur's boundaries. In the cultivated landscapes adjoining Bandipur, conflict between endangered elephants and marginal farmers is a serious problem both in terms of its impact on farmers, as well as the impacts of retaliating farmers on Bandipur's elephants.

The villagers outside Bandipur have historically depended on the forest for their biomass needs, chiefly fodder and fuel wood. Until recently, over three-fourths of all domestic fuel in the region came from firewood harvested from the forests. Likewise, local livestock, numbering over 125,000 also depend on the forests for grazing. This dependence is especially heavy during the monsoon, when nearly all land outside is under cultivation, leaving virtually no land outside Bandipur available for the cattle to graze. While livestock were previously reared by the agriculturists to haul the plough and for their manure, in recent times, there has been a thriving trade in cow-dung on which the livestock economy of the villages is now pivoted (Madhusudan 2005).

However, these economically vital activities like cattle grazing and fuelwood collection have had a devastating impact on Bandipur's forests, leading to habitat degradation for wild herbivores like elephants and wild pigs, and aggravating their natural predilection to forage on resource rich patches that crop fields represent to them. Farmers in villages flanking the forest, on average, lose 15-20% of their produce to wildlife, with farms directly adjoining the forest losing much more. This imposes a huge risk on an agricultural system that is already burdened with high interest rates for farm capital, and exacerbates the poverty

Nature Conservation Foundation, Mysore. mdm@conservation.in

in these villages (the average income in these areas is around 16,000 per year per family), leading to increased dependence on forest resources. Farmers often spend around 2,000 per annum—almost a quarter to a third of their total agricultural investment—towards protecting their crops by building thorn fences, buying fire-crackers, guarding their crops or paying others to guard them. If these additional costs of production to farmers were assessed in monetary terms (which it is not), a conservative overall estimate of the amount invested by farmers to protect a single monsoon crop around Bandipur would add up to a staggering 27 *crores*. When farmers face losses despite such high investment in crop protection, in desperation, they resort to lethal means to keep out wildlife from crops, including the use of fences electrified with live wires, or baited poisons or explosives. During 2009, over 33 elephants were killed in such electrocutions (Gubbi 2009), with many more possibly having died from other means of retaliation.

For its part, the forest department tries to manage the conflict by investing in digging elephant-proof (and cattle-proof) trenches and erecting electric fences around the forest. In addition, the forest department compensates loss of agricultural produce caused by wildlife. Between 2005 and 2010, the amounts paid out annually as compensation to farmers outside Bandipur has steadily increased from c. 35 *lakh* to nearly c. 70 *lakh* (Karnataka Forest Department, *unpublished data*). Despite seeming large, the forest department's compensation scheme seldom compensates more than 5% of the monetary loss of produce suffered by people due to human-wildlife conflicts (Madhusudan 2003), and even less if farmers' investments into crop protection is factored into the cost of conflict. However, in the long run, physical barriers such as trenches and fences fail primarily because, as much as they try to keep in the elephants, they also seek to keep out the local villagers who depend on Bandipur for fodder and fuelwood. The villagers have therefore generally responded by filling up trenches or breaching fences to gain access to the forest. These actions of people contribute to further degrade habitats, aggravating the tendency of wildlife to raid crops, which increases agricultural risk and lowers productivity to levels where farmers are further dependent on forest based firewood and grazing to buffer themselves against risk in agriculture. Farmers and wildlife are thus tied into a vortex of losses wherein, for their survival, wildlife become more dependent crops and farmers become more dependent on forests, thus increasing conflict even more.

APPROACH

In our pilot project covering the villages of Maguvinahalli, Kaligowdanahalli and Melkaamanahalli outside Bandipur, we viewed conflict as the costs the two interacting systems—the agricultural production system outside and the ecological system inside the park—impose on each other (Figure 1). The production system in the villages consists of three key modes of production: agriculture, livestock and gathering (of forest produce such as fuelwood and NTFP). The agricultural production system is affected by a number of risks and efficiencies (Figure 2), wherein the primary risk comes from increased production costs and crop losses due to wildlife depredation. The conservation system (Figure 3) too is also affected by risks, most of them originating from the production system. Hence, there was need for an intervention to break this cycle of risks between the two systems. This was done by erecting non-lethal solar-powered electric fences—not at the edge of the forest, but around affected farms—to mitigate the risk of wildlife depredation on farm production.

The fence was initially erected in 2008 in Maguvinahalli, but subsequently covered farmers from Melkaamanahalli and Kaligowdananahalli, such that eventually 59 families owning 100.2 acres was fenced in two blocks. The entire activity was conceptualized as a service being provided to the farmers rather than a philanthropic donation. The farmers paid an initial enrollment fee of 1,500 per acre protected and then a yearly maintenance fee of 300 per acre. These amounts were chosen with the purpose of keeping the costs below what the farmer was known to spend on ineffective means of crop protection. A cooperative was formed with the farmers as the members, and they assumed responsibility of collecting the fees and maintaining the fence, and in return, NCF offered them a no-cost lease of the fence for 3 years, at the end of which the cooperative would effectively take over the upkeep of the fence.

The fence managed to effectively remove the largest risk of animal conflict thus ensuring almost 95% reduction in crop loss within a year. Because it was installed around their fields, the fence did not obstruct the villagers' access to the forest, and therefore did not suffer the same fate as the fences that attempted to enclose the forest. A direct result of this was that the farmers in the cooperative started obtaining higher crop yields and the threat of retaliatory killing of elephants (and other animals) was removed, at least from those farmers who were beneficiaries of the fence. Other than this primary result, several other unforeseen positive effects were observed.

Within one year, nearly 50% of the families participating in the project managed to find funding and install tube-well irrigation systems. Farmers in this area, enthused by the mitigation of the major risk factor, moved from a risk-averse strategy of farming to a profit-maximizing strategy. All families within the fence now harvest three crops instead of one crop a year. From the 59 direct beneficiary families that have stable and profitable agriculture due to crop protection, about twice as many families in the village benefit indirectly by getting stable, year-round employment in their farms. With no time to herd cattle in the forest, the participating farmers now grow fodder in a part of their land that they do not mind setting aside for this purpose now, given higher production efficiency in the remaining land. Large herds of cattle earlier kept for their dung (which was sold as organic fertiliser) are being replaced by high-yielding milch cows that are stall-fed from farmed fodder and make larger contribution to farmer cash incomes from sales to a newly created local dairy. Further, as a result of increased income from their agricultural yield, farmers now prefer to invest in LPG connections instead of wasting valuable time gathering fuelwood illegally from within Bandipur. These families have almost stopped depending on fuel wood and fodder from the forests of Bandipur. This move has reduced their impact on the elephant habitats in Bandipur and has thus addressed one of the main drivers of conflict in this area.

Hence, the intervention aimed at mitigating the risk of wildlife on agriculture, has a significant effect in terms of reducing the fluxes between the production and conservation systems and has lead to improvement in the productivity of both systems (Fig. 4).

CHALLENGES

Bandipur is bordered by 180 villages with a population of about 140,000, which are affected by similar problems. Bringing these lessons to bear upon a problem faced by a large number of these villages can have a big positive impact on the conservation of the forest as well as on the welfare of the villagers. But before doing so, it is essential to consider the financial, institutional and social challenges encountered in this experiment. Relying on philanthropy alone for financing such an initiative is neither sustainable nor scalable. Hence, it is prudent to look towards more market-based institutions to generate, at least partially, some investment for this project. A market for crop protection already exists in these villages and an investment of 8 lakh on the fence has generated "revenue" of 2 lakh in two years. Hence, there exists a very real option of using the production system and the gains it experiences from the removal of key risks to finance at least some part of the investment and this needs to be explored.

A preliminary cash flow analysis on a representative villages and crops tells us that the pay-back period for investments into the fence could be as low as 5 years. This is based on the assumption that the increased returns after putting in the fence would be shared between the farmer and the investor. This figure is highly dependant on initial conditions like fertility of soil, as well as variables such as cost of capital for agricultural intensification, which can vary greatly across the landscape. Hence we need to have a set of options for different combinations of these variables. A very simplistic example of this would be the combinations of philanthropy and market-based investment (the term market investment is used here to imply financial investment that can be recovered from the returns generated by the investment) as the fertility and the cost of capital change. High cost of capital and low fertility, for instance, would require more philanthropy, while lower cost of capital and high fertility would make it possible to have more of market investment.

The institutional framework for managing this initiative is as important as the modes of financial investment. The institution should aim to build maximum ownership of the fence among the villagers and reduce the role of external agencies (such as NCF, in this instance) involvement to a minimum. The cooperative framework with which we have started seems to work well for a small number of families. However, following enlargement of one of the fences to include 39 new participating households in 2009 has resulted in serious social divisions, which have led one of the fences to the verge of a breakdown. However, I believe that a number of small cooperatives (<20 families in heterogeneous villages), each owning and managing the fence, collecting the charges and eventually repaying the investor is likely to be more sustainable than large-sized cooperatives. Other initiatives geared to reduce natural resource conflicts, like Namma Sangha (an extraordinary project that has made available LPG to over 30,000 forest firewood dependent households outside Bandipur since 2004), have also experimented with alternate institutional models where a separate independent organization manages all the operations in the role of a service-provider. This option, in particular, could help promote local enterprise (with assistance from funds available with the Rural Development Ministry, for example) as a key opportunity to address both the ecological and economic challenges.

Once social inequities have been addressed and local communities are soundly empowered, there may be avenues for larger, more formal argo-industry partnerships. Devising a sustainable and effective system of collecting returns is an important issue here. The need is to tap in to a revenue stream to allow the returns to be collected by the institution. This means that the institution has to get involved in buying and selling the agriculture produce, which is the main revenue stream in these areas. Milk from dairy farming is an alternative but it is not sufficiently developed in the region. The exact nature of the institution's involvement in these market activities needs to be established in order for a market based model for this initiative to succeed.

The social challenges in expanding this initiative lie primarily in the divisions of caste and class that exist in these villages. So far, the scheme has been kept agnostic to caste. A conscious effort has been made to bring in farmers with smaller land holdings by insisting on a minimum number of families for erecting the fence rather than any specific amount of land. However, enforcing such ideals of equity within social contexts that are deeply riven based on caste and class has the potential to render institutions such as the farmers' cooperative weak. There is hence a need to be aware of this factor and the potential complications it may result in.

A WAY FORWARD?

In the discussion above, a set of options for taking this initiative forward have been outlined. Based on the experience of working in the region and some preliminary analysis the suitability of some options over others is evident. The need is to test these hypotheses more formally in a set of villages covering the range of variables like land fertility, cost of capital, land holding size, social structure and institutional framework. The results from this exercise will enable the development of a robust strategy for expanding this initiative that addresses both human-wildlife conflicts and natural resource conflicts at the same time in a manner that is both knowledge-based and inclusive.

The key aspect of this is also that rather than striving to reduce natural resource conflicts in protected areas "by push", through creative opening of better opportunities in production landscapes, it may be possible to achieve the same ends "by pull". In other words, with no external push towards breaking their dependence on the forest, farmers had taken the step themselves. Of course, their motivations had little to do with concern for wildlife, but does that matter? If the pursuit of the all-too-human goal of an improved quality of life has added benefits for wildlife, is it not time to rethink current approaches to conservation?

Undoubtedly, the challenge of scaling up such an effort to match the enormity of the problem remains. But if conservation must come as a side-effect, should we shy away from the human development activities that precipitate it? Should conservation efforts continue to see wildlife conservation and rural poverty as completely distinct and separate problems, particularly when we encounter them together? Or is rural poverty tripping us up as we march determinedly, in blinkers, towards conservation?

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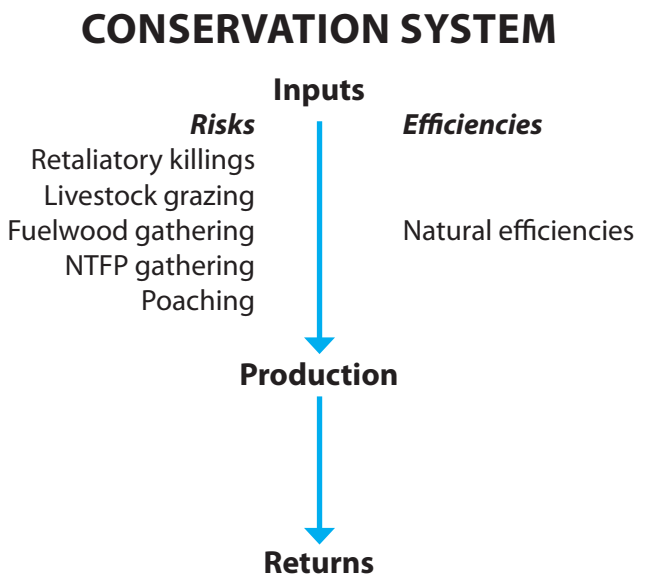

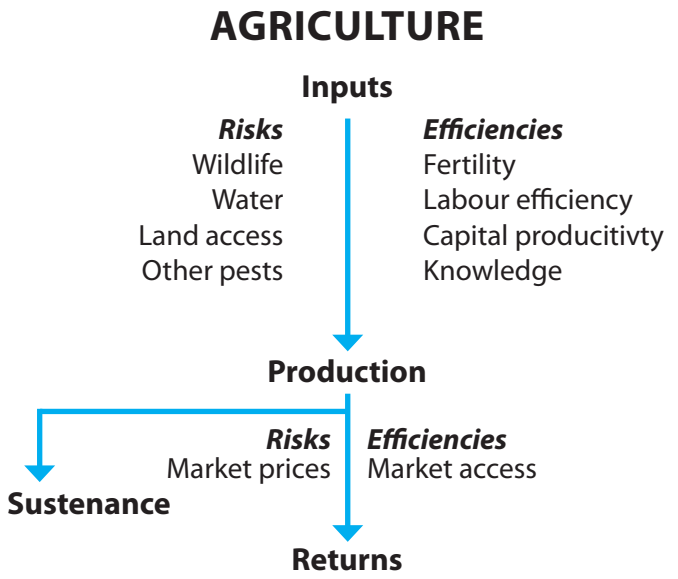

Figure 2: **The agriculture production system**

Figure 3: **The conservation system in a protected area**

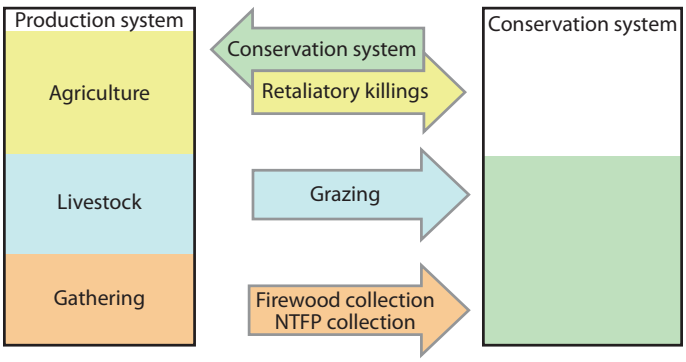

Figure 1: **Linkages between production and conservation (PA)systems**

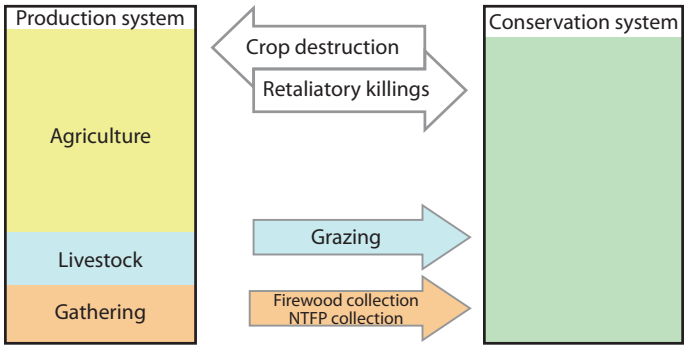

Figure 4: **The production and protected-area systems and the linkages after the interven**

Valuation of Forest Biodiversity – A Prerequisite for Better Financial Devolution & Developing Markets for Forest Ecosystem Goods and Services

Madhu Verma *

INTRODUCTION

There is growing concern worldwide about the destruction and degradation of natural ecosystems and the attendant loss of biodiversity (Pagiola et.al 2004). At the global level, on average, almost 15 million hectares of forest were lost every year during the 1990s, mostly in the tropics (FAO, 2001). 35% of mangrove forests have been lost in the last two decades (Valiela and others, 2001). Managed ecosystems such as agricultural lands have also become increasingly degraded. These losses would once have been of concern only to biologists, but growing awareness of the importance of natural ecosystems and the goods and services they provide has made ecosystem degradation an important concern worldwide (Pagiola *et. al.* 2004).

Same is the case of India whereon account of diversion, encroachment and thus depletion and degradation and reasonable slow pace of conservation and replenishment, biodiversity rich forests which provide wide array of ecosystem services, are facing tremendous challenges and subjected to substantial pressures. Traditionally, most of the forest resources are taken as "free gifts of nature". Though people are aware of their uses but not their value, resources have not only been used but overused, misused and finally abused (Verma, 2008). Some of these pressures are intentional effects of human activities, others are un-intended.

The scenario gets worse as we do not make an effort to appreciate the value of losses that we are incurring on account of such degradation. Many ecological services which are also lost in diversions have never been considered in taking such decisions. It is also not really known how to put a value on such services, when a region is reforested. The existing decision making process in the forestry sector of India has been based on a narrow knowledge base and is unable to visualize such unrecorded losses which are invisible but impactful. The current national accounting system does not give true signals about forest resource availability and its value which many a times contributes to the failure of policy on ground. Though the policies have good intentions but they result in bad outcomes due to insufficient information on which they have been formulated. Similarly there has been gross insufficiency of incentive mechanism for those who bear the cost of conserving such resources but provide many public goods in the form of positive externalities.

Thus lack of such an appreciation of true worth of forest resources in India has been causing huge losses to the sector and to country's economic system. The present national accounting system in India under-records tangible benefits and absolutely disregards the contribution of diverse ecological services by forests as no price tag is attached to such services for their use currently due to poor, thin, weak or totally absent markets for them. We are currently using wrong compass to get signal for availability or scarcity of forest resources. The main reason for this has been lack of understanding of its correct worth due to inadequate methodologies to generate complete set of information for both marketed and non marketed; priced and unpriced; provisioning, regulating, cultural and supportive services from forest ecosystem.

On account of our failure to gauge exact contribution of India's forests, our forest biodiversity rich states, especially the ones which are mandated to keep large areas under forests and tree cover, despite providing significant amount of ecosystem services in the form of public goods, are incurring revenue losses and lagging behind in developmental processes. Thus forest resource *abundance* which could have led to development of such States has proved to be resource *curse* for them and so called *'boon'* of forest richness has actually become a *'bane'* for them as in exchange of created *fiscal disabilities* to raise revenue and bearing high cost of provisioning of public goods, these States are neither adequately compensated nor any incentives mechanisms have been set up in the fiscal transfer process of the country for conserving their large forest areas in perpetuity. Moreover, fiscal devolution pattern in Indian planning process has been overwhelmed with *centripetal biases, vertical and horizontal imbalances and inadequate equity and efficiency concerns.*

Further, markets for forest ecosystem services can only be developed once the economic value of these services is estimated. Thus valuation is a pre-requisite for creating markets for ecosystem services (Verma, Kumar, *et al*. 2010). Valuation and accounting framework are needed for factoring in the intangibles from forests so to reflect the true contribution of the forestry sector to the Indian economy (Verma 2008). Such constructs are also essential

* Environmental Economist & Professor, Area of Environment and Developmental Economics, Chairperson, Centre for Ecological Services Management, Indian Institute of Forest Management, Bhopal. Email: mverma@iifm.ac.in

for encouraging investment in the sustainable management of forest resources through various PES mechanisms. Moreover, the role of forest ecosystem services in supporting livelihood and buffering against poverty and reducing vulnerability of the poor cannot be overlooked.

In India the forestry sector is currently highly undervalued despite its important role in the overall economic system and the true value of its contribution has not been fully recognized and internalized in the planning process of the country. Forest which should ideally be treated as capital, like other capitals in the economic system for the purpose of development like physical, human, social, intellectual and financial capital, fails to receive the attention on account of lack of reflection of its true productivity, receives less investment in the sector which further trigger low returns from the sector. As a result many States which are rich in forest wealth are still lagging behind in the race of developmental process despite being rich in forest capital. There is an urgent need to bring about *environmental fiscal federalism* such that financial allocations can be done on the basis of conservation of natural capital of the federal units of the country.

Thus the paper is an attempt to make a case of '*conservation of forest biodiversity'* and *'greening the forest sector'* by equipping the policy makers with the information regarding value of various ecosystem services of forests and developing green accounts such that a mechanism of compensation and rewards can be institutionalized for increasing budgetary allocations to the states conserving large forest areas under the policy directive. It further recommends for using the value as a base for developing markets for forests ecosystem service so as to incentivize stakeholders engaged in conserving India's biodiversity rich forests. It intends to provide strong connect of economic valuation with policy-institutional-market processes for sustainable management of forests and increasing wellbeing of populace of the country.

FOREST ECOSYSTEM SERVICES AND WELLBEING LINK

As stated in the last section, forest ecosystems provide a wide variety of useful services that enhance human welfare. Without these services, we would be worse off in many ways. At the limit, we may not survive. But even degradation of ecosystem services falling well short of outright destruction would significantly affect our welfare (Pagiola *et.al.* 2004). Forests and Wildlife are part of national wealth or stock as they contribute towards natural capital of the country. However, unlike many other goods and services these resources may not have an established and organized market, thus a price tag on many goods and services provided by them is missing which leads to undervaluation of their worth. The use, overuse, misuse or abuse of such natural resources is a flow towards the welfare of society. Since their use adds to the welfare and abuse reduces it, their valuation and accounting on the lines of capital formation is necessary to understand the state of welfare of the nation.

The exercise of Millennium Ecosystem Assessment (MA) carried out between 2001 and 2005, was an attempt to provide the report card of the health of various ecosystems of the world. It identified provisioning regulating, cultural and supporting services as four major services that the ecosystems provide to human beings for their livelihood security (Figure 1). It placed human well-being as the central focus for assessment,

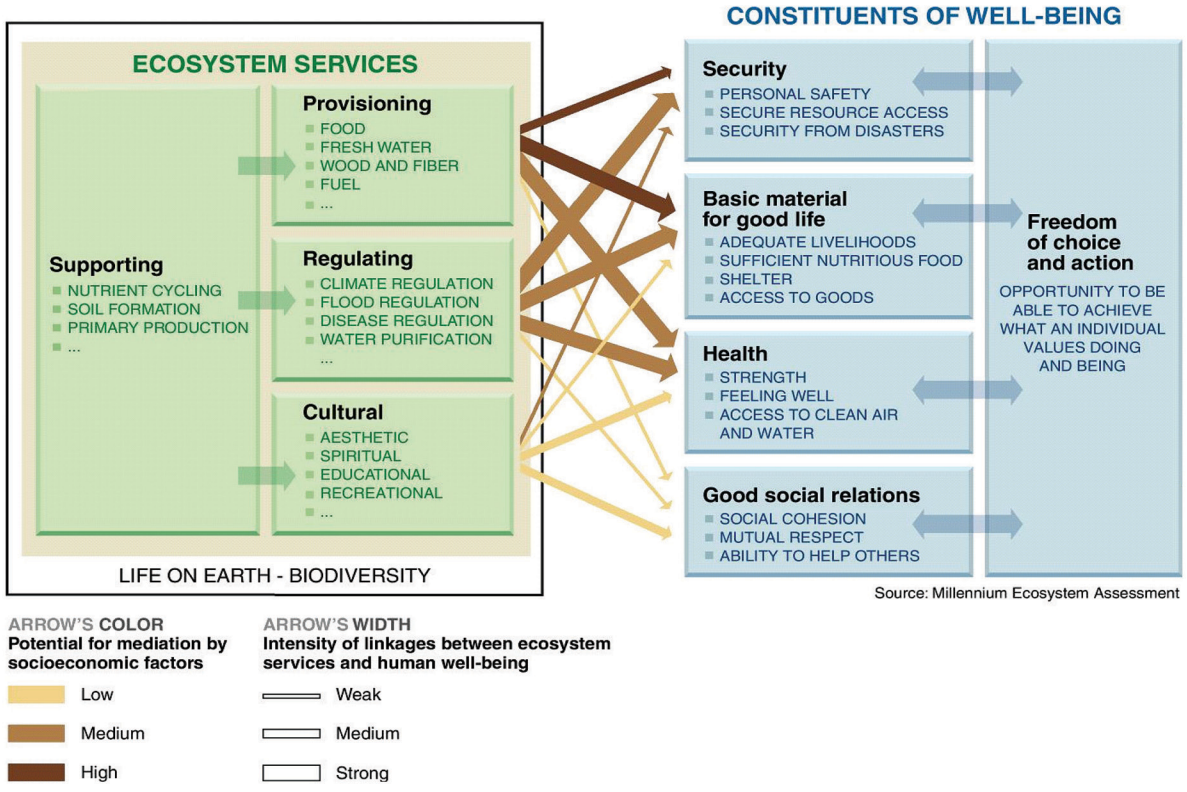

Figure 1: **Ecosystem Services and the Human Well-being**

while recognizing that biodiversity and ecosystems also have intrinsic value

The MA exercise highlights the importance of contribution of forest biodiversity and its ecosystem services in ensuring ecosystem health, resilience, food security in relation to livelihood security. Further it places emphasis on valuation of diversity of ecosystem services as it helps assessing current flow of benefits provided by services, in form that can be added up (*i.e.* green accounting), decides specific policies, i.e. assessing impact of specific changes in management of ecosystems and further understanding distribution of benefits (helps understand the incentives of individual decision makers and the equity consequences). Valuation process helps to measure the well-being impact directly which includes effort to quantify non-monetary benefits. Though the valuation is not the only criterion for decision, other objectives of society are distribution and intrinsic values.

RECENT INTERNATIONAL INITIATIVES TOWARDS RECOGNITION OF ECOSYSTEM SERVICES AND BIODIVERSITY

To make the case of conservation and to invite investment in natural ecosystems, it becomes pertinent to mention two international initiatives undertaken recently viz.; "The Economics of Ecosystems and Biodiversity" study during 2007-10 and the UNEP's" Towards a Green Economy" (2009-11). UNEP, in alignment with the UN International Year of Forests, 2011, under its theme for this year 'Saving Forests', is celebrating a multitude of services performed by the world's forests - providing clean air, housing rich biodiversity and supplying water, thus in regard its report gains considerable significance *The Economics of Ecosystems and Biodiversity* (TEEB) is a global study, initiated in 2007 by the G8 and five major developing economies that focus on 'the global economic benefit of biological diversity, the costs of the loss of biodiversity and the failure to take protective measures versus the costs of effective conservation. TEEB presents an approach that can help decision makers recognize, demonstrate, and capture the values of ecosystems and biodiversity. The values of nature vary according to local biophysical and ecological circumstances and the social, economic and cultural context. Intangible values, which may be reflected in society's willingness to pay to conserve particular species of landscapes, or to protect common resources, must be considered alongside more tangible values like food or timber to provide a complete economic picture of a country's natural wealth and its long-term sustainability prospects (TEEB D0, 2009).

Over the past three years TEEB has produced a series of reports, for distinct end-users, including policymakers and the business community. The TEEB report for National and International Policymakers demonstrates the value of ecosystems and biodiversity to the economy, to society and to individuals (TEEB D1, 2010). TEEB for Local and Regional Policy explores and gives practical guidance on how to deal with the challenge of biodiversity loss at the local and regional level. Finally, the TEEB for Business Report, launched in July 2010, enables easy access to leading information and tools for improved biodiversity-related business practice – from the perspective of managing risks, addressing ecosystem opportunities, and measuring business impacts on ecosystems and biodiversity. The TEEB approach allows for a systematic appraisal of the economic contribution of biodiversity and ecosystem services to human-wellbeing; and for routine steps to prevent that contribution being lost or diminished through neglect or mismanagement by helping equip governments with the means to incorporate the values of nature into decision making at all levels. TEEB Report brings out that the contributions made by forest ecosystem services to human wellbeing and the role of forests in sustaining livelihoods is not captured in the existing figures of forestry sector's contribution to the country's GDP. With a broader concept of GDP such as the GDP of the poor, which captures the reliance of rural populations on nature, the contribution of the forest sector is greatly increased (TEEB 2009).

On the other hand the UNEP's *Towards Green Economy* Report highlights capital misallocations and how the existing policies and market incentives have contributed to this problem as they allow businesses to run up significant, largely unaccounted for, and unchecked social environmental externalities. The reversal of reverse such misallocation requires better public policies, including pricing and regulatory measures, to change the perverse incentives that drive this capital misallocation and ignore social and environmental externalities (UNEP, 2011). At the same time, appropriate regulations, policies and public investments to foster changes in the pattern of private investment are increasingly being adopted around the world, especially in developing countries (UNEP 2010).

UNEP defines a *Green Economy* as one that results in "improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities" (UNEP 2010). In its simplest expression, a green economy is low carbon, resource efficient, and socially inclusive. In a green economy, growth in income and employment should be driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services. The report makes an economic case for shifting both public and private investment to transform key sectors that are critical to greening the global economy. It illustrates through examples how added employment through green jobs offsets job losses in transition to a green economy. It also shows how a green economy can reduce persistent poverty across a range of important sectors – agriculture, forestry, freshwater, fisheries, and energy. In the end, it provides guidance on policies to achieve this shift by reducing or eliminating environmentally harmful or perverse subsidies, addressing market failures created by externalities or imperfect information, creating market based incentives, implementing appropriate regulatory frameworks, initiating green public procurement, and by stimulating investment. It reasons importance of such an approach especially for poor people whose livelihoods and security depend on nature and further gives the rationale of transition to a green economy is to eliminate the trade-offs between economic growth and investment and gains in environmental quality and social inclusiveness.

In its key message for the forests, it considers them as foundation of the green economy, sustaining a wide range of

sectors and livelihoods; asserts that short-term liquidation of forest assets for limited private gains threatens this foundation and needs to be halted; it expects that International and national negotiations of a REDD+ regime may be the best opportunity to both protect forests and ensure their contribution to a green economy; stresses the need for need for creation of a catalogue payment mechanisms for forest ecosystem services and promotion and scaling up of such services; assess scope for green investments in natural forests and plantations; and supports for importance of legal and governance changes that are needed to tip the balance towards sustainable forestry.

The above studies draw many parallels to Indian Forestry sector scenario, hence their recommendations for valuation exercise, green accounting and incentive based mechanisms which have been demonstrate through many exemplary and influential cases can be internalized in our planning process for sustaining our forests resources in perpetuity.

FOREST CAPITAL OF INDIA

In case of India forestry and agriculture are the two most important land uses in the country, the latter competing with the former under relentless pressure of an ever increasing population, which has grown from 361 million in 1951 to 1,028 million in 2001 and to 1,210 million in 2011. As per the latest estimate of the India State of Forest Report (India-SFR 2009), the forests constitute 21.02% of total geographical area of the country. The area under tree cover outside forests is reported to be 2.82%. Thus the total of forest and tree cover becomes 23.84% (78.37 million ha) of the geographical area of the country (328.73 million ha). The decadal change in the forest cover (1997-2007 assessment) as per India-SFR 2009 has been 31,349 km^2 (4.75%). The per capita availability forests has, thus, declined considerably from 0.08 ha in 2001 to a minimal figure of 0.06 ha in 2011, which is one of the lowest in the world. However, 41% of the forest cover of the country is degraded.

Realizing the need for conservation and regeneration India is putting key emphasis on developing capacity to promote forest conservation. It has a National Action Plan on Climate Change (NAPCC) which has eight sub–missions which strategize low carbon economy for the country. One of the sub-mission "Green India Mission" focuses on the forestry sector and has an overarching goal to double the afforested and forested land of the country to 20 million ha by the next decade. But the forests in the country have been disturbed significantly through logging, clear felling, grazing, fire etc. With the growing population, pressure on forest is increasing considerably as a result of which unsustainable harvesting practices are followed to meet their daily energy and livelihood needs leading to rapid depletion of forest stock. The fast growth of the Indian economy is putting additional demands on the forests land for infrastructural and industrial development with increased requirement of diversion of forests land for the purpose of hydro electric projects, mining etc. (FSI 2009). Figure 2 explains category wise land diversion since 1980 till present under Forest Conservation Act of 1980

During last three decades 33% of forest land has been diverted due to encroachments, which can be attributed to increase in population, human needs and industrialization. Hence it becomes even more important that the forests stocks are conserved and enhanced so that they support livelihood of the people and also help in mitigating the climate change. The point of concern here is that in such cases of land diversion, true value of forest ecosystem services lost is not being compensated though it is recently charged as per NPV committee recommendation (2006), but the value and the formula devised for fixing such a charge is gross underestimate of diverted forests true value thus needs correction. As a matter of fact, the mechanism estimating the economic value of forest ecosystem services is yet to be standardized for estimating the value of conservation or degradation of forest.

VALUATION OF FOREST BIODIVERSITY CONSERVATION

Creation of protected areas to restrict access and certain land-use practices has been the dominant approach used by governments to secure ecosystem services by controlling deforestation and forest degradation. Thus in order to protect the critical ecosystems

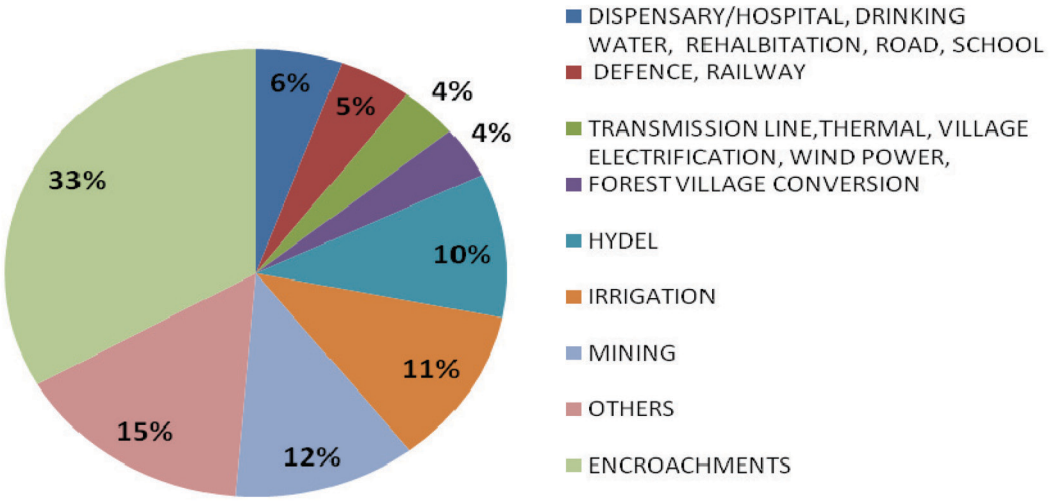

Figure 2: **Land Diversion under FC Act 1980: Category Wise (1980-2010)**

Data Source: MoEF (2010

and also to preserve the genetic resources of un-quantifiable commercial as well as non-commercial values, 95 national parks and over 500 wildlife sanctuaries, and two conservation reserves have been created in India, over the years, with the prime objective of preserving them as samples of interdependent ecological gene-pool combinations and a gene-bank capital. These are all under tremendous pressure caused by human interventions. Almost 40% of these protected areas are subject to effects of traditional livestock grazing, fodder extraction; timber extraction, non-timber forest produce collection and more than 45% have public thoroughfares dissecting them into smaller parts.. These pressures are increasing with the rapid rise in the population of the country. The disproportionately large human and livestock populations have made setting aside 4.7% of country's geographical areas under the PA system increasingly difficult. People are not aware that more than 300 rivers originate in India's national parks and sanctuaries and many more do so in the forestlands outside these protected areas. Besides these designated areas, many critical floral and faunal species which lie outside the protected areas also need urgent attention for their existence but no provisioning is currently being done in the existing forest budgets of the States. Thus unless true worth of any forest conserved or diverted is understood and the benefits and costs of conservation are spread across various stakeholders, biodiversity rich forests will continue to face challenges and strive for their continued existence.

Thus it is evident that mere creation of protected areas and obtaining physical estimates of forests or forest cover are not of much significance unless we convert such physical estimates into monetary measures or some qualitative measures to mirror the dependence of varied stakeholders and eventual stress on forests. Valuation thus helps in ascertaining the value of conservation versus value of degradation or diversion of forest. Further it not only helps in understanding amount of benefits but also who gets the benefits and who bears the cost. Environmental decision-makers must make choices between options that are often characterized by a wide range of conflicting impacts, which are expressed in incommensurable units. Impacts may be expressed in physical terms (e.g., change in forest cover), monetary terms or qualitatively. To simplify decision-making it is advantageous to convert these impacts to a commensurable unit (Verma, Kumar, et al. 2010).

Economic value estimates and measures are based on people's preferences. It is generally assumed that individuals, and not the government, are the best judges of what they want. People express their preferences through the choices and trade-offs they make (Kumar, Verma, et.al 2010).Valuation of forest resources is essential (i) to generate an appreciation for ecosystem services emanating from Forests amongst all Stakeholders, (ii) to do full cost/value/price accounting not to charge for all services (may be for some services) but to provide incentives to the communities, other stakeholders conserving forests and make a claim for better allocation of funds for the states and to help the department and others stakeholders to achieve the intended outcome, (iii) to reflect the real value of Investment in the forest sector i.e. outcome of expenditure and to influence the public policy to get benefits of International and national market mechanisms for conserving communities and to exercise appropriate Gender Budgeting, and (iv) to suggest appropriate instruments to generate environmental and conservation finance for sustainable forest management.

To probe deeper into various issues confronting forests of the country, the paper presents major findings of some exemplary, action research based cases of India for the states of Himachal Pradesh and Uttarakhand are shared where the valuation of forest ecosystem services has been taken forward to introduce an economic instrument or being used for increased budgetary allocation for forest resource conservation. It also shares major findings of recently accomplished study of the author for the Thirteenth Finance Commission which estimated values of ecosystem services of the forest in various states which was in turn used to build case for increased budgetary allocation from the Thirteenth Finance Commission of India.

Case1: **Economic Valuation of Himachal Pradesh Forest for HPFSR (Verma, 2000)**

The IIED-DFID supported work as a part of the Himachal Pradesh(HP) State Forestry Review exercise, titled "Total Economic Valuation of Himachal Pradesh Forests" estimated worth of HP forests as Rs. 106664 crore. Watershed services have the maximum contribution of 70% of revised GDP. For the entire forest sector an annual value was estimated at Rs. 7.43 lakh per hectare and Rs. 7.89 lakh for per hectare area under forest cover. This valuation exercise was instrumental in the introduction of an economic instrument named as Compensation for the Loss of Ecological Values **(CLEV)** in 2002 which has been used to charge for the total economic v alue loss of ecological services on account of forest diversion. The values have been widely used for various decision making processes and for seeking increased compensation from the centre for forest conservation and currently been used in preparing a case for carbon credits as a reward for providing of carbon sequestration services.

Case 2: **Values of Ecosystem Services from Uttarakhand Forest (Verma, 2007)**

The first attempt to calculate a global value for natural resources was done by a team of researchers from the United States, Argentina, and the Netherlands led by Robert Costanza, put an average price tag of US$33 trillion a year on these fundamental services from various ecosystems.(Costanza, 1997). It identified 17 specific goods and services provided by ecosystems: gas regulation, water regulation, water supply, erosion control and sediment retention, soil formation, nutrient cycling, waste treatment, pollination, biological control, refugia, food production, raw materials, genetic resources, recreation and cultural services. The Costanza study provided a revealing but rough estimate of the magnitude of ecosystem service values on a global scale, and the reported values can serve as a basis for estimates relevant to specific regions or ecosystems. Monetary values of ecosystem services of Uttarakhand Forest have been worked out using the estimates of tropical forest category in Costanza's study according to which Uttarakhand's forest area generate Rs 31293 crore worth of ecological services annually besides the tangible ones which are though partially recorded in the system of accounting of the state income. Amongst the ecological services the nutrient cycling function adds the maximum value of Rs 14,298 crore, followed by value of raw materials (Rs 4,912 crore), Erosion control and sediment retention

(Rs 3,818 crores), recreation (Rs1,745 crore), climate regulation (Rs 350 crore), genetic resources (Rs 639 crore) and food production (Rs 497 crore). Low values were found for water supply and regulation, soil formation and noise disturbance. The values so generated have been used by the department for preparing cases of compensation from the central government for sustained maintenance of Uttarakhand forests.

Case 3: **13th Finance Commission of India study on 'Developing Mechanisms for Increased Budgetary Allocation for States managing large geographical Areas under Forests (Ve& Bhagwat, 2008-09)**

The study used three approaches for estimating the economic value of forest biodiversity of the States which were (i) total economic value, (ii) opportunity cost and (iii) correction costs approaches to prepare case for states for an increased award of grant in aid for their existing forests stocks and increments thereof. The paper discusses here the Total Economic Value (TEV) approach and specific methodologies adopted for various ecosystem services (Table 1). For estimating the value of forest ecosystem services, various methodologies used by varied authors have been considered. Firstly, a set of common goods and services was identified that comprehensively captures the various ecosystem functions of forests. Efforts have been made to choose a set such that double counting is avoided. Then for each identified service the available methodologies adopted by various experts were studied and the one that best fitted the estimation process at macro level as per the authors' perception was adopted. The ecosystem functions have been broadly divided into two types of benefit flow viz. stock and flow services. The stock functions provide an indication of the resource stock of a State representing the extent of natural capital reserve in a State. Carbon storage and bioprospecting value are the functions that attempt to capture the stock value of forests in the current approach. The rest of the functions are flow values that emanate out of the stock. The flow values are further divided into two parts direct use values or provisioning functions like supply of timber, fuel wood and other forest products and the indirect use values constituted by regulating services like soil erosion control, water regulation and climate regulation. The indirect use values are the positive externalities that arise out of the forest ecosystems and are like welfare functions for the society at large. As the pressure on the forest ecosystems increases in the form of excessive extraction, the provisioning levels get hampered. To have a sustainable flow of services, the extraction needs to be regulated.

In the present context, an attempt is made to give monetary values to flow and stock values of forest in different States. The flow values have been estimated for the forest cover as given in

Table 1: **Adopted methodology for TEV estimation**

Ecosystem goods and services	Ecosystem function description	Adopted methodology
Timber	Provision of wood for commercial purposes	Standing timber extracted annually valued at a price point adopted from NPV committee report
Fuelwood	Provision of fuelwood for household purposes	Consumption approach based on NSSO survey estimates adjusted for census 2001 population and price levels of 2005
Fodder Collection	Collection of fodder for household livestock	Consumption approach based on NSSO survey estimates adjusted for census 2001 population and price levels of 2005
Grazing	Grazing of livestock in forest lands besides the fodder collection	Fodder consumption approach adopted by Rajasthan Forest Department based on conversion to equivalent cow units and valued at prices for in situ dry fodder
NTFP	Supply of edible products and raw materials of medicinal value	Production approach based on NPV committee estimates of NTFP per hectare for various forest stratums across the States
Recreation	Source of leisure, knowledge and religious importance	Consumer surplus based approach adopted by GIST framework.
Water Augmentation	Enhancement of ground water recharge by storage & retention	Water/hydrological balance method based on empirical findings by GIST framework
Soil Erosion control	Prevention of soil loss by binding the soil particles	Productivity loss approach and empirical findings for soil loss through erosion as worked out in GIST framework
Carbon Sequestration	Regulation of atmospheric carbon balance	Net accumulation/ release of carbon for the accounting year by adopting GIST and Verma framework
Carbon Storage	Sink function for carbon held by forest biomass	Methodological framework developed by the IPCC and documented in the Good Practice Guidance for Land Use, Land Use Change and Forestry (GPG) and adopted from Verma framework
Genetic resources	Source of diverse materials of genetic importance	Bio-prospecting value adopted from Verma framework based on probability of hit

Source: Verma & Bhagwat, 2009

SFR 2005 report by FSI. An attempt has been made to provide a picture of the benefit flow from forests for the year 2005. It has been assumed that this benefit flow is more or less constant from year to year especially after year 2000 onwards. Due to limited availability of data, average values based on past trends have been calculated and utilized where data for the year 2005 was not available. These estimates are broad estimates and no precision is claimed by the author.

For the estimation purpose, various components of TEV have been broadly classified as (i) Provisioning services covering timber, fuel wood, grazing, fodder collection and NTFP, (ii) regulating services having Carbon Sequestration, Soil Erosion control and Water augmentation (flow values) & Bio-prospecting and Carbon storage (Stock value), (iii) cultural services – recreation. The findings of the estimation process are presented in Table 2.

The table shows that value derived from carbon storage and bio-prospecting benefits forms a major portion of the TEV amounting to be more than 95% in most of the cases. The flow benefits in States that have less anthropogenic pressure far exceed the forestry contribution to GSDP, while in some States where the carbon sequestration values are negative; the contribution gets offset by the negative values. The values so generated were internalized in the following formula for Indian states which was recommended for increased budgetary allocation to affect the

Table 2: **TEV estimation by common methodology**

(Amount in Million Rs)

States	Direct Consumptive Benefits	Indirect Consumptive Benefits	Sub Total Direct Benefits	Sub Total Indirect Benefits	Total TEV
Ecosystem Services	**Timber, Fuelwood, Fodder, Grazing**	**Recreation**	**(I)**	**Carbon Sequestration, Soil Erosion control & Water Augmentation, Carbon Sorage, Bioprospecting**	**(I + II)**
Andhra Pradesh	3408.93	425.78	3834.72	421,957.61	425,792.33
Arunachal Pradesh	907.78	3.63	911.42	673,376.92	674,288.34
Assam	1325.28	52.92	1378.19	326,400.74	327,778.94
Bihar	2798.83	108.77	2907.60	33,003.67	35,911.27
Chattisgarh	6071.14	75.47	6146.61	348,774.41	354,921.02
Goa	6.44	255.49	261.93	6,075.02	6,336.94
Gujrat	6237.61	249.13	6486.74	115,399.66	121,886.40
Haryana	536.30	3.05	539.36	3,669.20	4,208.56
Himachal Pradesh	5280.69	1341.81	6622.50	396,083.38	402,705.88
Jammu & Kashmir	1532.09	221.68	1753.77	289,912.63	291,666.40
Jharkhand	2018.68	74.20	2092.88	133,451.37	135,544.25
Karnataka	3103.11	853.61	3956.72	474,392.26	478,348.99
Kerala	1163.67	2278.71	3442.39	223,179.10	226,621.48
Madhya Pradesh	11481.69	125.91	11607.60	321,672.66	333,280.26
Maharastra	6728.05	248.92	6976.96	295,881.50	302,858.46
Manipur	252.85	23.70	276.55	148,052.26	148,328.81
Meghalaya	973.12	652.76	1625.88	142,859.73	144,485.61
Mizoram	474.80	1.62	476.42	74,872.44	75,348.86
Nagaland	1144.89	830.05	1974.94	119,396.21	121,371.15
Orissa	6882.65	356.77	7239.42	371,183.64	378,423.06
Punjab	623.02	21.88	644.90	12,643.08	13,287.98
Rajastan	12210.27	444.14	12654.41	35,578.87	48,233.28
Sikkim	214.52	15.66	230.18	63,658.82	63,889.01
Tamil Nadu	1947.13	1220.70	3167.82	288,852.39	292,020.22
Tripura	130.10	1904.40	2034.50	63,771.84	65,806.35
Uttar Pradesh	8965.20	380.37	9345.57	202,557.89	211,903.46
Uttarakhand	3396.58	476.05	3872.63	513,633.96	517,506.59
West Bengal	1618.27	1691.52	3309.79	168,621.74	171,931.53
India	107129.96	14132.45	121262.42	6,211,529.47	6,332,791.88

Source: Verma & Bhagwat, 2009

$$A = \frac{1}{4}\sum_{i=1}^{28} GS_i X + \frac{1}{4}\sum_{i=1}^{28} DC_i X + \frac{1}{4}\sum_{i=1}^{28} BPS_i X + \frac{1}{4}\sum_{i=1}^{28} CS_i X$$

process of environmental fiscal federalism.

Where,

X = *Equalization Factor*

GSi = $\dfrac{\textit{Total Growing Stock of the } i^{th} \textit{ state according to SFR } 2005}{\textit{Total Growing Stock of the Country according to SFR } 2005}$

Growing Stock of a state

$$= \sum_{j=1}^{14} \frac{\textit{Geographical area of all the districts of the state lying completely in } j^{th} \textit{ physiographic zone}}{\textit{Total geographical area of the } j^{th} \textit{ physiographic zone}}$$

$\times$ *Growing stock of* j^{th} *physiographic zone*

$$= \sum_{j=1}^{14} \frac{\textit{Geographical area of all the districts of the state lying completely in } j^{th} \textit{ physiographi zone}}{\textit{Total geographical area of the } j^{th} \textit{ physiographic zone}}$$

$\times$ *Growing stock of* j^{th} *physiographic zone* $\times$ 0.5

$$CS_i = \frac{\textit{Total Carbon Storage value of the } i^{th} \textit{ state}}{\textit{Total Carbon Storage value of the Country}}$$

Though the above formula holistically attempted to internalise the economic values of forests but the actual award but the eventual award of 13th Finance Commission of India again largely based on the another formula recommended to the commission by the authors to internalise the Protected area factor and another factor introduced by the commission that of densities as per the following.

$$G_i = \frac{\left[\left\{\frac{F_i}{\sum F_i} + R_i\right\} \times \left\{1 + \frac{M_i + 2H_i}{A_i}\right\}\right]}{\sum_{i=1}^{n}\left[\left\{\frac{F_i}{\sum F_i} + R_i\right\} \times \left\{1 + \frac{M_i + 2H_i}{A_i}\right\}\right]}$$

Where

G_i = *Share for state i*

A_i = *Geographical area of the state i*

F_i = *Total forest area of state i*

M_i = *Moderately dense forest area of state i*

H_i = *Highly dense forest area of state i*

$$R_i = \max\left[0, \left\{\frac{F_i}{A_i} - \frac{\sum F_i}{\sum A_i}\right\} / 100\right]$$

As seen from the formula, the 13th Finance Commission of India has three main factors for allocating grant to the states:

i. Share of the total forest area in the country falling in any particular state;
ii. Moderately dense forest area of the state; and
iii. Highly dense forest area of the state.

Though some forest rich states have received considerable amount of grants for sustaining their forests biodiversity but there is need to establish a permanent system of generation of revenue through some innovative mechanisms and the engaged stakeholders need to be suitably rewarded as described in the next section.

VALUATION AND PES

The emergence of the concept of payments for ecosystem services has raised expectations among many stakeholders that ecosystems can be conserved through popular payments to ecosystem service providers rather than through unpopular measures of command and control. The basic logic is simple: those that provide ecosystem services by foregoing alternative uses of the land should be compensated by the beneficiaries of that service. In case of Indian Economy, the existing institutional mechanism could be tapped and further strengthened to reduce the transaction cost of the establishing such markets. As a follow up of 1988 forest policy, large numbers of Joint Forest Management (JFM) Committees have been set up across the country promoting forest conservation. As of 2005, there are about 99868 JFM committees across India with about 13.8 million families involved out of which approximately 35% are scheduled families. Similarly, the century old community forest management through Van Panchayats in Uttarakhand State, Lok Vaniki (i.e. a forestation activity on private lands) and Autonomous Development Councils (ADCs) in North Eastern States are existing institutional mechanisms which could be strengthened and used for the purpose of achieving the target of 33% forest and tree cover of the country on one hand and generating benefits and revenue for conserving communities and forest department on the other hand But the current benefit generation and distribution system against the efforts made by

the participating communities is not encouraging enough to sustain their interest in forest conservation in perpetuity.

Thus the valuation exercise can be taken forward to set up the compensation, reward, payment, market or incentive based mechanism such that the interest of stakeholders remains sustained and investment becomes attractive in the natural capital i.e. forests and the country can get benefit at the international platform for its REDD and carbon management efforts via expected REDD fund and carbon credits. It stresses the need for capacity building of all concerned in the scientific understanding of natural capital, as well as in the design and implementation of finance mechanisms and supporting policies and institutions to effect valuation, accounting and payment process for improving livelihoods and increased budgetary support. Strengthening of the community and the governance mechanism by capacity building and demonstration activities should simplify the impediments in way of successful implementation of the REDD+ projects (Lal *et.al,* 2011)

SUMMARY

The paper attempts to build the case of environmental - fiscal federalism wherein by internalizing the environmental contribution of the forestry sector, fiscal imbalances amongst the developed - forest deficient and under developed – forest rich States could be reduced. The paper in the end suggests policy intervention in the form of strengthening existing institutions and establishment of market mechanism for generating stream of payments, compensation and reward for forest conservation.

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Constitution of Forest Ecosystem Services Regulatory Authority for Developing Effective Market Mechanism for the Forest Ecosystem Services

Dr. Dvijendra K. Sharma, Dr. Vinay Sinha, Prof. HS Gupta

1. INTRODUCTION

Forests perform many protective and regulating functions in addition to providing tangible goods like timber, fuelwood, and fodder and non-timber forest products. While the tangible goods have markets and its values are available to the owner of the trees/forests, the non-tangible Forest Ecosystem Services have very little or undeveloped markets at present. But, these Forest Ecosystem Services are essential for very existence of living being and for improvement in their quality of life.

The contribution of forestry and logging sector to the Gross domestic Products (GDP) in India has been valued at around one percent because only recorded values of timber, fuel wood and NTFPs are counted towards contribution to GDP. Inspite of the fact that, 170,000 villages outs of total 587,000 villages in the country are contiguous to forests and depend on the them heavily for their requirements, the investment in the forestry sector continues to be low. Thus, non-tangible Forest Ecosystem Services and major portion of unrecorded removals are left outside the purview of the GDP. This under estimation of the forest values is reflected in the annual plan outlay to forestry and wildlife sector in the country, which continues to be only about 1% of total plan outlay. Therefore, forests can not be regenerated and developed to the required extent due to paucity of fund. This has adversely affected the livelihood security and employment opportunities of people dependent on forests.

To achieve the national goal of bringing 33% area under forest cover by 2012, substantial degraded land both private as well as government has to be reforested. Considering the availability of 60 million hectares degraded lands for tree planting, budgetary allocation of Rs 1,200 billion (@ Rs 20,000 per hectare) will be required to rehabilitate them (Saxena, 1996; Anon., 2004). It is indeed a stupendous task both in financial and physical terms. Public-private partnership efforts can take care of the greening of only about 4-5 million-hectares degraded land area. There is still huge gap between requirement and availability of funds for reforestation and other forestry activities on remaining degraded land. Government of India has taken initiative in this direction by collecting Clean Energy Cess on the sale of fossil fuels and its allocation for climate change adaption and mitigation projects including Green India Mission, which has afforestation and planting as major component.

Cost of conservation and development of forests are local but benefits flow to all levels, from local to global. All the beneficiaries of Forest Ecosystem Services should therefore, contribute for the development of forests. In this backdrop, only possibility to conserve and develop forests appears to be by evolving market-based system for Forest Ecosystem Services . Market based mechanism will require operation of the independent regulator so that benefits of the Forest Ecosystem Services are valued and forest service adjusted tariff are charged from the end users in an unbiased manner. In Costa Rica, 'environmentally adjusted water tariff' to maintain and reforest watersheds, has been implemented since the year 2000 (Pagiola, 2002). (Box 1). In India, payment for Forest Ecosystem Services has analogy in Net Present Value of the forest land; cost of catchment area treatment, compensatory afforestation, rehabilitation of mined out areas; and environmental cess on extracted stone metal from quarries in New Mumbai. These payments are made by the user agency for the diversion of forest lands for non-forestry works under Forest (Conservation) Act, 1980. This can be extended to private land

Box 1: ***Eco-Markets Project in Costa Rica***

Eco-markets Project has been implemented in Costa Rica with the support from the Global Environment Facility (GEF) and World Bank to facilitate the production of forest/ environmental services. The project objective is to increase Ecological Services by developing markets and the consumers for the services provided by forests of mostly private landowners. Benefits of reforestation to hydroelectric generation were estimated to be about US$ 20/ hectare/year on an average that was used as base for negotiations among parties. Biodiversity conservation and carbon storing services have also been envisaged for compensation in this project. Payments for forest conservation are about US$ 35-40/ hectare/year and for reforestation contracts over five years is US$ 538/ hectare. Carbon stored by the forests has been valued from US$14 to $20 per tonne of carbon The program has attracted many landowners for signing contracts. In the year 2000, Costa Rica approved a law to set up 'environmentally adjusted water tariff'. The revenue from this mechanism will flow to maintain and reforest watershed areas in selected locations (Pagiola, 2002) (Bishop and Landell-Mills, 2002).

areas also. While all the Forest Ecosystem Services are important, some of them can be easily identified, quantified, negotiated and assigned for developing a payment system for Forest Ecosystem Services. This paper proposes creation of Forest Ecosystem Services Regulatory Authority (FESRA) for effective development of market mechanism for the ecological services.

2. VALUING FOREST ECOSYSTEM SERVICES

Forest ecosystems including tree cover play important roles in providing ecological services. Hydrological (water) services, biodiversity value and Carbon sequestration services are few of them that can be traded. To highlight the need for sustainable management of forest resources and consequential beneficial effects, economists and researchers have made efforts to assign values to each category of the benefits from the forest ecosystems. This valuation include- (i) Use Value-Direct Use Value (DUV), Indirect Use value (IUV), Option Use Value (OV) and (ii) Non-Use Value – Bequest Value (BV) and Existence Value (EV) expressed by following equation (Mathur and Sachdeva, 2003).

Total Economic Value (TEV) = UV + NUV = (DUV+IUV+OV)+ (BV+EV).

Verma (2000) has estimated that total economical value (TEV) of forests of Himachal Pradesh as 2.89 lakh per hectare for goods and services in terms of total forest area in the state. The TEV in terms of tree cover and scrub forests in the state of Himachal Pradesh has been estimated to be Rs 7.43 lakh per hectare. Some important Forest Ecosystem Services like recreational, aesthetics and eco-tourism are widely marketed through entrance fees, residential property markets etc. Forest benefits like watershed protection, biodiversity conservation and carbon sequestration have also been valued but their markets are developing slowly. Manoharan (2000) has listed results of few Indian case studies, conducted to identify and assign values to such ecological services of the Indian Forests (Table 2).

3. CREATION OF FOREST REGULATORY AUTHORITY FOR MARKET MECHANISM FOR FOREST ECOSYSTEM SERVICES TO OPERATE

Pagiola (2002) has discussed the payment mechanism for Forest Ecosystem Services in Costa Rica. Though, government controls major forest areas in India, the private individuals also have ownership of many forests. But, these private individuals are not sufficiently motivated to conserve and propagate forests on their lands as the costs involved are higher than the returns from them. Further, people living in and around forests maintain these forests for the benefit of the people living away from forests. Hence, the payment for Forest Ecosystem Services to the landowners in catchment areas as well as to people living near around to compensate the ecological services their forest generate, can motivate them to keep their land under forests. These people can thus include these incentives while making land use decisions, resulting in more economically, environmentally and socially optimal land uses (Pagiola, 2002). This paper proposes payment mechanism for Indian conditions that is illustrated in Figure 1.

Forest Department is also trustee of forest areas on behalf of the society and therefore responsible to conserve and develop this resource for the present and future generations. Hence, the forest department also becomes eligible to share the payments for Forest Ecosystem Services. This is imperative in the present context because limited financial resources are available for the forestry sector from the governmental plan funds. Any additional funds generated from non-tangible Forest Ecosystem Services can provide employment opportunities to the people living in and around forests. This way their co-operation for conservation and development of forests can be ensured.

Following Forest Ecosystem Services provided by the forests can be considered for such an arrangement (Table 3). The list of beneficiaries is only indicative and many others could be added.

TABLE 2: **Economic Values of Some Selected Benefits from Indian Forests**

Selected Benefit	Value of Annual flow	Location	Source
Recreation / Eco-tourism	Rs. 16197 / hectare (Rs.427/Indian visitor)	Keoldeo National Park, Bharatpur	Chopra (1998)
Eco-tourism	Rs. 676 / hectare for locals	Periyar Tiger Reserve, Tamil Nadu	Manoharan (1996)
Water Supply	Annual rental Rs. 4745 / hectare	Almora forests	Chaturvedi (1992)
Soil Conservation	Rs. 21583 / hectare	Doon Valley	Kumar, (2000)
Ecological function (Use Value) for locals	Rs. 624 / hectare	Yamuna Basin	Chopra and Kadekodi (1997)
Carbon Store	Rs. 20125/ hectare	Indian Forests	Haripriya (1999)
Soil Conservation	Rs. 2.0 lakh / hectare meter of soil	Lower Siwalik (Yamuna basin)	Chopra and Kadekodi (1997)

Source : Manoharan (2000)

TABLE 3: **Some Forest Ecosystem Services provided by the Forests**

Service	Benefits	Beneficiaries
A. Carbon Sequestration Services:		
Fixation of Carbon-di-oxide	Control on Climate change	Global Community Carbon buyers Citizens
B. Biodiversity Conservation:		
Biodiversity Values (India is one of the 12 major biodiversity zones of the world. Biodiversity has immense value in agriculture and pharmaceuticals sector)	Development of new chemicals. Development of New Vaccines. Development of new plant variety through crop breeding program. Insect and pest resistance in the food crops	Global Community Agriculture and Pharmaceutical industries. Other Industries. Citizens
C. Hydrological (Water) Services		
Reduced sediment load to Reservoir	Increased life of reservoir. Lower maintenance cost.	-Hydroelectric Plants -Irrigation Department -Drinking Water Supply Department (Municipalities) -Fisheries Department -Agriculture Department
Regulating water flows	Reduced flood risk Reduced drought	-Flood Control Department -Disaster Management Units -Agriculture Department -Rural Development Department -Population in flood risk zones.
Improved quality of Available Water	Lower pollution risks from pesticides, fertilizer and other human activities.	Drinking Water Supply Department (Municipalities)
Recharging of Ground Water	Increased availability of water in Tube-wells, Ring-wells & Hand pump.	Population in zone nearby the forests.
D. Other Services		
Pollution Control	Control of Air, Water, Land and Noise Pollution	Industries Citizens Global Community
Eco-tourism	Recreation	Tourists Pilgrims
Aesthetics and Shade	Good feeling	Residents Passerby

Initially, operational hydroelectric, municipal drinking water supply, industrial and irrigation project, having clear linkages to the Forest Ecosystem Services should be identified for developing a payment mechanism. After creating demonstrable projects, extension to other areas will be smoother and easier.

This will require operation of independent regulator, may be called-'Forest Regulatory Authority'. Following issues have to be addressed by him while designing, implementing and sustainably operating a payment system for Forest Ecosystem Services .

- Identification and quantification of Forest Ecosystem Services. Identification of key beneficiaries.
- Designing Forest Ecosystem Services charges for beneficiaries.
- Development of a system for payment to landowners.
- Deciding Environmentally Adjusted Water / Electricity Tariff, Pollution Tax on petroleum, minerals and ores etc.
- Political, legal and institutional issues.

The economic values of Forest Ecosystem Services generated by various types of forests have been calculated by few researchers, which can be used with some modification for a specified watershed (Table 2). Beneficiaries and the end users can be identified based on the flow of the benefits (Table 3). The payment amount should be preferably more than opportunity cost of landowner but not too high to discourage beneficiaries. Similarly, agreement period for such Forest Ecosystem Services and efficient fund transfer mechanism is equally important for continuing relationship among different stakeholders.

Payment for the Forest Ecosystem Services by beneficiary agencies to the landowners can be met by decreased annual cost of operation and maintenance of hydroelectric generation units

/ water supply units etc. by way of increased reservoir life. At the same time, regulatory authority should also fix the tariff for electricity / water; pollution tax on petroleum, extracted minerals and ores etc. after evaluating the environmental costs and benefits. Interest of the marginalized section of people like poor and tribals, fishermen and small landholders have to be taken care while fixing tariff.

Modification of existing tariff of electricity, drinking water, irrigation and industrial water to accommodate the Forest Ecosystem Services will require legal, political and institutional backup. Similarly, payment for carbon sequestration, biodiversity, pollution tax on petroleum, minerals and ores will require comprehensive discussion at national and international level. Central, State and local governments can play proactive role for implementation of payment mechanism. The transaction cost for Forest Ecosystem Services may be kept low by collecting it along with the tariff for water and electricity. Initially, government may support the payment program by providing subsidy through State and National Board for Forest Financing. This subsidy may be phased out slowly as the revenues from payments for Forest Ecosystem Services increases. Internalization of the Forest Ecosystem Services cost in electricity/water tariff, petroleum/mineral price may have salutary effect on sustainable management of natural resources.

4. LEARNING EXPERIENCES

4.1 A case for Conservation of Watershed Areas for providing Water supply to Mumbai Metropolitan area:

Tulsi, Vihar, Tansa and Powai lakes, supply water to the Mumbai Metropolitan area. Major requirement of water, however, is met from Lower and Upper Vaitarna Dam, Bhatsa Dam and Barvi Dam. Catchment area of these reservoirs needs protection for sustainable water supply. This undermines the development of the surrounding rural areas. If catchments of the lake or dam are not protected, its water will become non-potable, for example-deterioration of catchment has already made water of Powai Lake in Mumbai unfit for drinking. There is however, a way to create win-win situation for both urban and rural population i.e. by urban population paying for treatment of catchments and rural population receiving payments for conserving forests on their lands as well as getting employment at site.

Consider consumption of 125 lts. of water per person per day, and population of Mumbai-Thane area to be 18 million urban and Rs 1 per 1000 lts (over and above present water rate of Rs 5 per 1000 lts.) as fee towards hydrological services provided by the forests. In this scenario, approximately 125 lts.*18 million*365 days*Rs 1/1000 lts = Rs 82 crore per year fee towards water services provided by the forests can be collected from domestic water consumption. Keeping all other factors same, another 50-60 crore can be collected as water services fee from industrial water supply in the same area. This amount can generate about 13-million mandays (@Rs 100 per man-day) work for rural and poor people in the catchments for various activities. For example, it can help in developing sustainable water management and conservation of the forest and wild life areas, which in turn will also motivate the private landowners to keep the land use of their land as forests. This concept can also be extended to other water supply programmes in other cities.

4.2 Afforestation Programme by Tirupati Thirumala Devasthanam(TTD):

Many temples and shrine exist in the forest areas. Forest provides different services like shade, aesthetics, and emotional values in addition to other common benefits like clean air etc. to the pilgrims visiting these places. TTD, which has annual offerings etc. of Rs. 450 crore has established a separate forestry wing to look after the forest and tree cover in and around the holy place. The TTD management committee has also taken lead by appointing one forest officer on its board for forestry works. Even if, only 10% of the offerings are spent for greening of the area around these religious centers, it will not only provide resting-place to devotees in the summer but also improve the surrounding environment.

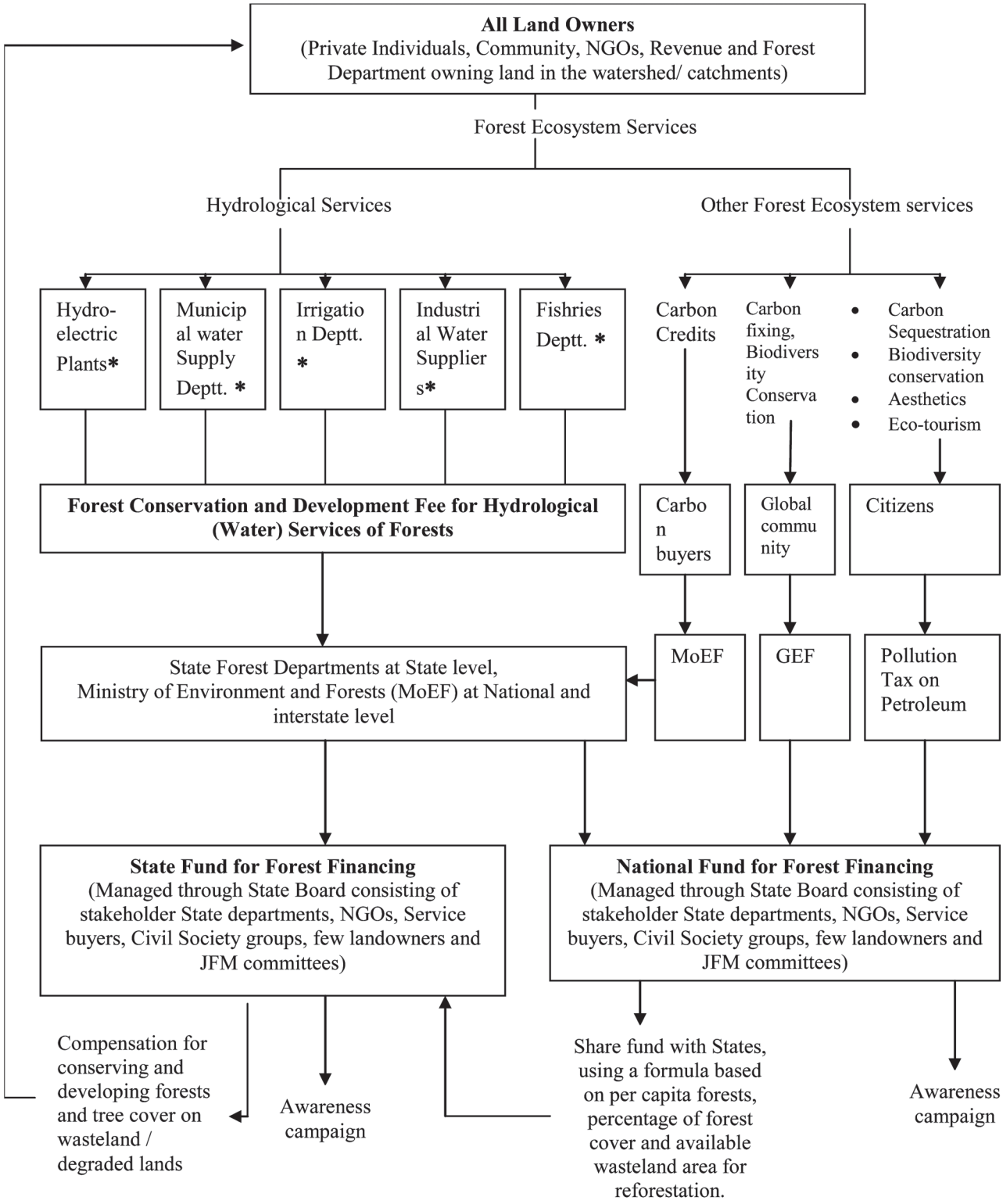
4.3 Pollution Tax on Petroleum:

Fossil fuel like petroleum and coal add net carbon to the atmosphere and the forests are the only resource, which sequesters the atmospheric carbon. While major consumption of coal is for energy, and cement industry, the consumption of petroleum is mostly for transport sector. Energy and Cement industry can be asked to purchase carbon permits for the amount of the pollution caused by them. However, pollution tax on petroleum will help in fixing the each citizen's liability also towards Forest Ecosystem Services. Taking petroleum consumption of 2.185 million barrels per day (347million liters per day), rupees 35 crore per day (@ of Rs. 1 per liter pollution tax) can be collected for making payment towards the Forest Ecosystem Services generated by the landowner's forest and tree cover.

7. CONCLUSION

Private individuals have ownership of many forests in India in addition to government controlled forests. Limited financial resources have restricted the development of both government and private degraded lands, which continue to remain poor performing assets. One of the possibilities to ameliorate the degraded lands appears to be by developing market-based system for Forest Ecosystem Services provided by the forests grown on them. Market Based approach can provide powerful additional incentives for rural livelihood by offering new source of income to support in addition to conserving forests.

Developing a payment system for Forest Ecosystem Services requires identification, quantification, negotiation and assignment of value for ecological services. A structure for payment of Forest Ecosystem Services to landowners and collection of environmentally adjusted water / electricity tariff from user agency or public; pollution tax on petroleum, minerals and ores; contribution by temple and shrines in forest areas could form a basis forest conservation and development. This will require operation of independent regulator, may be called-'Forest Regulatory Authority'. This Authority may decide these issues for developing the effective market mechanism for Forest Ecosystem Services provided by forests.



* They collect environmentally adjusted tariffs for Electricity, water etc. From User agencies and public.

Figure 1: **Proposed Structure for payment of Forest Ecosystem Services to Landowners in Watershed / Catchments**

(Modified and developed after Costa Rican Eco-markets Program), Source: Pagiola, 2002

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Ecotourism: An Approach to Sustainable Livelihoods

A.K. Bhattacharya* and Apoorva Singh**

BACKGROUND

Tourism is one of the fastest growing industries but commercial exploitation of natural areas for mass tourism is posing a threat to ecosystems. Ecotourism, being the only non-consumptive use of natural resources, is one of the most effective ways to ensure development hand in hand with conservation. Continuous reduction in timber harvesting throughout India has led to the decline of revenue to the exchequer and loss of employment to local people. With an increase in protected areas, local communities also receive fewer benefits from the forestry sector, and the locking up of prime forest resources within Protected Areas (PAs) has further aggravated their hardship. Both these realities have led to unsustainable use of forests outside protected areas, conflict between PAs and people.

With money from ecotourism, jobs for local people become available and health and education of local people can be improved. These health and education improvements can go a long way in alleviating poverty, population growth and land distribution problems, which are the main causes of natural resource degradation and biodiversity loss. Owing to its potential, the revenue generated from ecotourism activities can be significant, and should be used both for conservation, as well as a means of livelihoods and economic benefits for local communities. Apart from benefiting local economies, ecotourism also fosters appreciation and respect for nature among visitors, thereby building education and raising awareness among the common populace.

Increasing human populations and their demands on natural resources make it almost impossible to leave large areas undeveloped. It is, therefore, imperative that natural areas must produce economic benefits without jeopardizing the resource base itself. Ecotourism has become an appropriate and effective tool to achieve this goal. There is an urgent need to have a holistic national framework for developing ecotourism as a source for conservation and livelihood.

** Chief Executive Officer, MP Ecotourism Development Board*

** Manager Training, MP Ecotourism Development Board*

DEFINITION AND OBJECTIVES

The International Union for the Conservation of Nature (IUCN) defines 'ecotourism' as "environmentally-responsible travel and visitation to relatively undisturbed natural areas, to enjoy, study and appreciate nature (and accompanying cultural features, both past and present), that promotes conservation, has lower visitor impact, and provides for beneficially active socio-economic involvement of local populations."[1]

Ecotourism ('ecology' and 'tourism'), draws upon natural, human-made and cultural environments. Ecotourism is travel to experience natural environments or settings.

ECOTOURISM OBJECTIVES

(i) Avoids negative impacts that damage or destroy the natural or cultural environments being visited;

(ii) Educates the traveler on the importance of conservation;

(iii) Directs revenues to the conservation of natural areas and the management of protected areas;

(iv) Brings economic benefits to local communities and directs revenues to local people living adjacent to protected areas;

(v) Emphasizes need for planning and sustainable growth of tourism and seeks to ensure that tourism development does not exceed the social and environmental "capacity";

(vi) Retains majority revenue in the local community by stressing the use of locally-owned facilities and services.

SUSTAINABLE LIVELIHOODS APPROACH IN ECOTOURISM

Livelihood essentially means the capabilities, assets, and activities required for living. The livelihoods can only be sustainable when they have a capacity to absorb shocks and are resilient towards stress and are continuously adapting with the changes in the environment. It has to work on enhancing its capacities for working in the present scenario as well as adopt for future while focussing on judicious use of natural resources.[2]

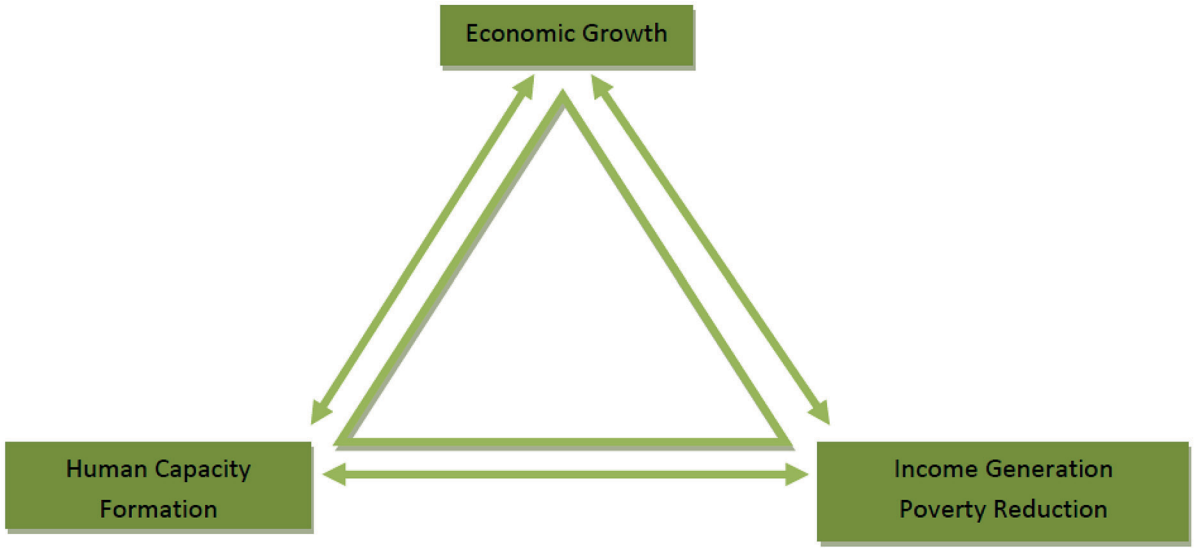
The Sustainable Livelihoods Approach developed by British Department for International Development (DFID) can be very well applied in ecotourism. The framework firstly outlines certain principles for development i.e.

i) People Centred

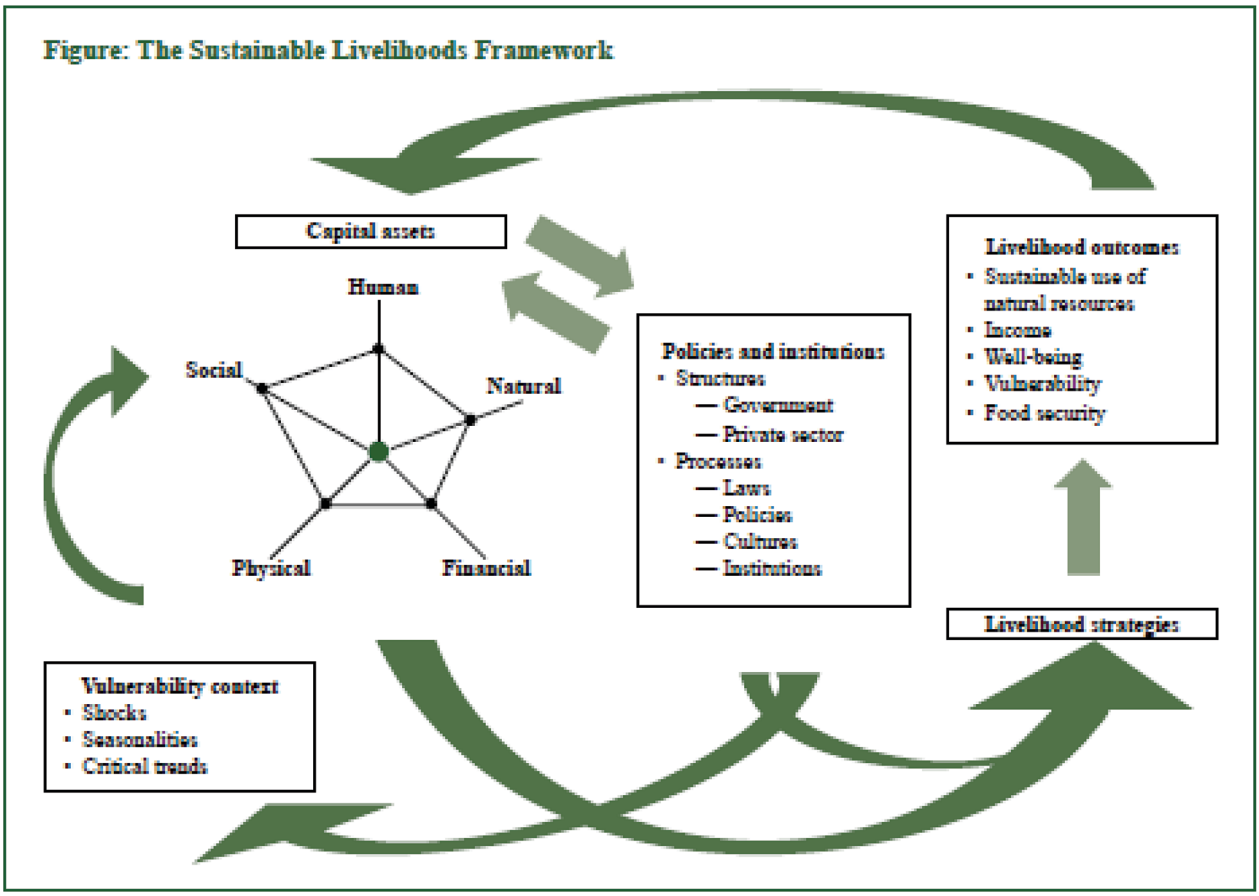
ii) Responsive and participatory

[1] http://data.iucn.org/dbtw-wpd/html/Tourism/section5.html (last visited on 11 August 2011 at 21:15 Hrs).

[2] The Sustainable Livelihood Approach by Oliver Serrat, Knowledge Solutions – November 2008



(Feedback loops at the macro – economic level (Human Development Report 2011)



Source: Department for International Development of the United Kingdom.

iii) Multilevel
iv) Conducted in partnership
v) Dynamic
vi) Sustainable – Economically, institutionally, socially and environmentally.[3]

These principles are in cohesion with the objectives of Ecotourism laid down in the previous section. The feedback loop presented in Human Development Report 2011 also showcase the inter linkages between capacity building in the communities and reduction in their poverty level and increase in their income generation which will ultimately lead to economic growth. Thus SLA as an approach can be very well used to understanding the concept of sustainable livelihood options in ecotourism for people living in forested areas and can be applied in understanding the dynamics which play important role in building and sustaining the ecotourism models and destinations. The framework for SLA clearly documents the relationship between the influencing factors in the rural economy.

OPERATIONALIZING ECOTOURISM

Ecotourism can be effectively operationalized by communities if capacities are developed as per the SLA Framework. The existing models of Community based Ecotourism can prove to be an idealistic model for community development and sustainable livelihoods. CBE includes Ecotourism enterprises that are owned and managed by the community and involves conservation, business enterprise and community development. There can be various models within this framework like:

1. Self-Initiated and community managed, e.g. Kokkrebellur, Karnataka
2. NGO Initiated and community owned, e.g. Rampuria, Darjeeling; Pastanga, Sikkim
3. Co-managed i.e. Community Managed and Government Supported, e.g. Bamboo Groves, Kerala

If ecotourism is to be sustainable and truly benefit local communities, then it is necessary that local people are trained and empowered as stakeholders in ecotourism enterprises, rather than just being offered employment. However, care must be taken to ensure that the rules are tight enough to ensure that only those people who are native to the area (perhaps those who were resident in the area prior to the creation of the Protected Area) should benefit from these schemes.

Schemes that provide training to local people must be implemented. Such training schemes should involve the cooperation of the management of local resorts. Additionally, schemes of positive discrimination in favour of local ownership of ecotourism enterprises must also be implemented. Local people can develop expertise as guides, provide accommodation, own vehicles and set up local handicrafts outlets to earn revenue from ecotourism.[4] Different areas have various rights and concessions and based on which Ecotourism can be viewed differently for the four areas mentioned below and herein the locals can be involved as follows:

i) For Ecotourism Entrepreneurship in Protected Areas

The locals can be involved in guiding, homesteads, local service outlets (vegetable hawkers, cobblers, mechanics, cleaners, etc.), souvenir shops, arts and handicrafts, vehicle owners and drivers, conducting ecotourism activities (boating, cycling, nature trail, etc) and other Park management activities.

ii) For Ecotourism Entrepreneurship in Forests outside Protected Areas

The locals can be involved right from the planning stage, helping in developing the site ecotourism plan acting as field resources. They can act as entrepreneurs running activities like cafeterias, arts and handicrafts outlets, performance arts groups and other ancillary activities. For employment, they can be employed as guides (for nature and cycling trails), boatsmen, managers at interpretation centers, helping staff for cafeteria, adventure activities, etc.

iii) For Ecotourism Entrepreneurship in village areas

In village areas the villagers can collaboratively work for development of entire site and run homesteads**.** Small homesteads (with 3-4 rooms) where local people provide accommodation to tourists in their own houses may be promoted. They can act as local tour operators who can organise tours and packages for tourists including exposure visits to their farms, sacred groves, NTFP centers, etc. They can operate traditional centers for publicizing their culture, traditions, arts, crafts, foods, etc.

iv) For Ecotourism Entrepreneurship in *Ex situ* Conservation areas (Ecological Gardens, Zoological Parks, Botanical Gardens, Eco-Parks and Biodiversity Parks)

In such areas locals can be involved in maintenance jobs like gardeners, cleaners, field staff, guards, caretakers, etc. They can operate ecotourism activities and guided tours to the areas and can be included in various ground-truthing and data collection activities.

v) Advanced Community Based Model

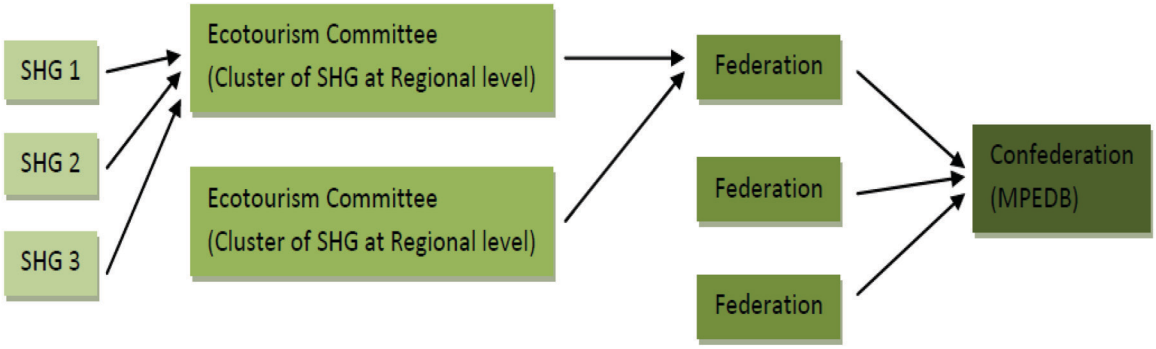
An advance model which can be used can be **SHG – Confederation model**. In this model different activities and facilities at a destination can be run through SHGs of the local community created under format of Ministry of Rural Development. The group of SHGs can be then clubbed to form a cluster at district level which can be referred as a destination (range) level ecotourism committee. A federation combining clusters of the district (division) can be created and ultimately a state level confederation overseeing the working of all the federations can be constituted. MPEDB can act as the confederation.

[3] Sustainable Livelihood Approach in Rural development by Ms. Salam Saab, FAO for Expert Group Meeting on Adopting the Sustainable Livelihoods Approach for Promoting Rural Development in the ESCWA Region Beirut, 21-22 December 2009

[4] Bawa, KS et al, Conservation Biology – A primer for South Asia, (Universities Press (India) Pvt. Ltd., Hyderabad, 2011), 58

SHG Confederation Model

JFMC level Activity based SHG (like Camp management, nature interpretation, adventure sports)	Destination (Range) level Ecotourism Committee (Cluster of SHGs)	Division level Federation of Ecotourism Committees	Circle / State level Confederation of Ecotourism Federations
SHG - A 1	EC – Y 1	F - 1	CF
SHG – A 2			
SHG – A 3			
SHG - B 1	EC – Y 2		
SHG – B 2			
SHG – B 3			
SHG - C 1	EC – Z 2	F - 2	
SHG – C 2			
SHG – C 3			
SHG - D 1	EC – Z 2		
SHG – D 2			
SHG – D 3			



As the local communities would initially be very vulnerable, the sector would need to be monitored and regulated. Government policies and guidelines need to ensure that:

1. There exists viable economic opportunities and increased contributions of communities in each of the ecotourism sites,
2. Majority income is retained in the local areas, through local employment, local procurement and community development commitments,
3. There are proper systems for regulation and accreditation of services provided so that best practices are adopted and environmental damage is minimized,
4. There exists initiatives to improve visitors' awareness and sensitivity to environmental issues,
5. Ecotourism is small scale, slow growth and has local control,
6. Natural resource management concerns are addressed by all stakeholders, and
7. The local culture is not excessively exploited.

CONCLUSION

In conclusion it can be derived that community development vis-à-vis economic development should be integral to every project. Community being the major stakeholder in any natural resource rich area should be the primary focus of the project. Ecotourism has a huge potential to provide communities a sustainable way to earn livelihood with judicious use of available resources. Thus focussing upon community based models for ecotourism will help in catering to both the objectives of conservation and livelihood.

CITES Implementation in India: Issues and Challenges

Samir Sinha I.F.S. *

Wild populations of flora and fauna are under a very high degree of threat today. While loss and fragmentation of habitats is a major cause of such threat, high levels of unregulated and unsustainable exploitation of wild animals and plants and their derivatives has in many situations emerged as the single most cause responsible for driving many wild populations towards extinction. Much of this trade is in the international domain, driven by high economic profits and encompasses millions of specimens of thousands of species across hundreds of countries each year.

Man's exploitation of wildlife for profit is not a recent phenomenon and the international trade in wildlife has been widespread for many centuries. In earlier times, some of this trade caused the decline of wildlife populations , but this was neither as frequent as this century nor regarded as a matter of any great concern. The world was a better place then, with fewer people. The critical factors that changed were the huge expansion in the human population and the rapid development of modern systems of transport and communications.

Many such species have already passed the point of no return, while several others survive where captive populations far outnumber wild populations. However, there are still many endangered species for which, if immediate steps are taken, the situation can be still rescued. There are others, which are not threatened with extinction for now but may become so, unless we regulate their utilization to levels that are compatible with their continued survival

Clearly, there is need for a framework to regulate such trade to help ensure the survival of threatened wild species. CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) has emerged as the global tool for strengthening wildlife conservation through regulation of international trade in wild species and their derivatives.

AN INTRODUCTION TO CITES

CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

The text of the CITES convention was agreed at a meeting of representatives of 80 countries in Washington DC, United States of America, on March 3,1973, and the convention entered in force on July 1, 1975. As such, the convention was also known as the "Washington Convention" in its early days. Today, it accords varying degrees of protection to more than 30,000 species of animals and plants, whether they are traded as live specimens or parts and derivatives.

CITES as a convention was believed to be ahead of its times as when it was formed, ideas about international regulation of wildlife trade as a measure towards conservation was relatively new. It touched upon highly emotive issues such as the exploitation of nature for profit, the capture and killing of wild species and the illegal trafficking of wildlife and derivatives Today, international wildlife trade is estimated to be worth billions of dollars annually. A significant part of this trade is believed to be illegal and includes a very large number of plant and animal specimens. The trade is diverse, ranging from live animals and plants to a vast array of wildlife products derived from them, including food products, exotic leather goods, wooden musical instruments, timber, tourist curios and medicines. Levels of exploitation of some animal and plant species are high and the trade in them, together with other factors, such as habitat loss, is capable of heavily depleting their populations and even bringing some species close to extinction. The existence of an international agreement to ensure the sustainability of the trade is important in order to safeguard these resources for the future.

For many years CITES has been among the conservation agreements with the largest membership, now with 175 Parties.

WILDLIFE TRADE

Wildlife trade refers to the sale and exchange of wild animal and plant resources. This includes ornamental animal products such as corals for aquaria, reptile skins for the leather industry, tortoiseshell, as well as ornamental plants such as orchids and cacti. It also includes timber products, medicinal and aromatic products such as taxol, agarwood, musk, fisheries products and live animals for the pet trade including parrots, raptors, primates, and a wide variety of reptiles and ornamental fish.

The trade in wildlife is diverse, ranging from live animals and plants to a vast array of wildlife products derived from them, including food products, exotic leather goods, wooden musical instruments, timber, tourist curios timber, fish, other food products and medicines. Most wildlife trade is probably within national borders, but there is a large volume of wildlife in trade internationally. Many forms of wildlife trade is not an offence but a significant part of the trade is illegal and in violation of

* Head, TRAFFIC India, WWF India Sectt., 172-B, Lodhi Estate, New Delhi 11000

international and national regulations and legislations.

In India, trade in wildlife resources has always been pivotal in the livelihoods of a large number of people especially the tribals. Communities living around forest areas have been dependent on natural resources for their survival. They have engaged in trade of forest produce either for cash or on a barter system to be able to meet their house-hold requirements. However such trade was mostly sustainable and did not severely impact the survival of the plant and animal species. Of late, this scenario has changed. Driven by overall human population increase and related consumer demand, including "modernized" collection, harvesting and transport means, the need and greed within people involved in the trade has become commercialized and, when illegal, has taken shape of a well organized clandestine operation. The value of legal global international wildlife trade, including non-CITES species and based on declared import values in 2005, is conservatively estimated to be about EUR 249 billion per year, with timber and fisheries accounting for about 90% of this value. As a comparison, the UN Statistics Division records the declared import value of the global trade in coffee, tea, and spices in 2005 at about EUR 14 billion; while domestic sales of medicinal plants in China was valued at around EUR 19 billion in 2002, and has increased by 8% a year since 1994

ILLEGAL WILDLIFE TRADE

Illegal wildlife trade refers to sale or exchange of wild animal or plant resources, trade of which is prohibited under law. In India, illegal wildlife trade includes diverse products ranging from mongoose hair, snake skins, rhino horn, Tiger and Leopard claws, bones, skins, whiskers, elephant tusks, deer antlers, Shahtoosh shawls, turtle shells, musk pods, bear bile, medicinal plants and timber through to caged birds such as parakeets, mynas and munias.

A large part of this trade is driven by international demand as many such products command a high price is certain markets. It is in this context that CITES Implementation in India becomes all the more important.

EUROPOL estimated in 2011 the revenues generated by trafficking in endangered species at **18 to 26 billion euros per year**, with the EU the foremost destination market in the world. The trade is principally coordinated by well-organized, loose networks based in the EU and in the source regions. [1]

IMPACTS AND THREATS OF ILLEGAL WILDLIFE TRADE

The threats posed by illegal and often unsustainable trade in wildlife can be serious. The *irrevocable loss of species and biodiversity is considered as the most significant of such losses*. If current trends in illegal wildlife trade are allowed to continue, scientists believe that a large number of animal and plant species, including many endemic species, will be wiped out this century. Beyond direct species losses, poaching to supply wildlife trade disturbs delicate ecosystems, often triggering effects that adversely impact *entire ecosystems*. For natural resource -dependent people, such impacts can be even more devastating, striking at the roots of their food and livelihood security. It can lead to collapse of any ecotourism in the area and overall cause severe economic *losses to already marginalized and less well off communities.*

In addition to the serious threats the trade presents to biodiversity, it is also important for other reasons. Wildlife trafficking poses health threats, as some diseases, such as avian influenza, SARS, the Ebola virus and tuberculosis, can jump from animals to humans, especially when those animals are removed from the wild and move in commerce.

INDIA AND CITES

India is globally acknowledged as one of the 17 mega diverse countries. With only 2.4% of the land area, India accounts for 7-8% of the recorded species of the world. India is equally rich in associated traditional and indigenous knowledge. Given its rich biodiversity, India also faces a large number of threats to its wildlife heritage, including habitat destruction and illegal wildlife trade.

India has been a member of CITES since 1976. While this is indeed a reflection of the seriousness this topic has been viewed even since its early days, the practice of effective CITES Management in India has several aspects that merit attention. Despite an experience in CITES implementation of over 35 years, India does not have a CITES specific law as on date; it is interesting to note that the international trade in wildlife is regulated through the EXIM Policy, under the Customs Act. This anomaly is likely to be addressed by a proposed amendment to the Wildlife (Protection) Act 1972.

India has on 6th June 2007, established a Wildlife Crime Control Bureau, a federal agency with the mandate under the Wild Life (Protection) Act, 1972 to combat organized wildlife crime. This is a much needed step to strengthen wildlife law enforcement within the country and to support CITES implementation. However, the reach and impact of the WCCB need to be considerably strengthened for it to make a significant dent. India has also established a CITES Cell at the level of the CITES Management Authority in the Ministry of Environment and Forests. This includes independent experts, NGOs and representatives from the Director General of Foreign Trade, Ministry of Agriculture and the Ministry of External Affairs. The cell is providing valuable support towards the implementation of CITES in India.

Despite this, threats to Indian wildlife continue almost unabated. Opportunistic poaching of high value species such as tigers, elephants, rhinos and leopards continue to happen across the country. Many more species, including live birds, star tortoises, marine products such as sea cucumbers and medicinal plants are targeted in high volumes but we have very little information on the scale and impact of such illegal removals. The smuggling of Red sanders, a highly valued timber species endemic to parts of Andhra Pradesh and Tamil Nadu has reached epidemic levels and over 250 tonnes of this wood has been seized by the enforcement officials in Nepal over the last 4 years! In recent times, Bangladesh has emerged as a major transit point for wildlife products from India and several seizures have been made involving wildlife species of Indian origin being routed to South East Asia though this country. Moreh in Manipur and various border posts along the Indo Nepal and Indo-China border are also highly vulnerable points for this trade. Clearly, much more needs to be done on this front.

Given the transnational nature of threats to wildlife, collaboration at regional level becomes an essential strategy to counter such threats. India has supported the establishment of the South Asia Wildlife Enforcement Network (SAWEN), which was launched at an inter-governmental meeting hosted by the Royal Government of Bhutan on January 29–30, 2011, in Paro. The establishment of SAWEN is a very crucial, timely and much needed step forward to institutionalize the collaborative efforts of member nations in controlling wildlife crime in the region. India's support and commitment to work together with its South Asian neighbors to protect our precious natural resources from illegal pillage and plunder will only help strengthen CITES implementation in the region.

At the international level, the Secretary-General of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Secretary-General of ICPO-INTERPOL, the Executive Director of the United Nations Office on Drugs and Crime (UNODC), the President of the World Bank and the Secretary-General of the World Customs Organization (WCO) have recently signed a Letter of Understanding to establish the International Consortium on Combating Wildlife Crime (ICCWC). This international consortium will work with countries to provide a coordinated global response to such threats. This will also encourage and develop a culture of cooperation and criminal intelligence sharing amongst nations and agencies to stop transnational trafficking in endangered species."

Recently, INTERPOL has under the aegis of ICCWC launched "Project Predator", a new campaign to coordinate the global fight against tiger poaching, warning that failure to protect the endangered cats would have economic and social repercussions. The campaign is designed to help coordinate efforts of police, customs and wildlife officials in Bangladesh, Bhutan, Burma, Cambodia, China, India, Indonesia, Laos, Malaysia, Nepal, Russia, Thailand and Vietnam.

Project Predator, which has US, British and World Bank funding, will also share information with conservation agencies in an effort to raise awareness.

THE CHALLENGES

Wildlife crime has clearly emerged as a form of organized transnational crime. Like all organized crime, this needs an organized response. As a crime of the twenty first century, it cannot be fought with a nineteenth century mindset or twentieth century tools. It is a problem we must collectively respond to as it involves all of us, whether in and out of government, in one form or another.

The issue is not just about saving animals from extinction – as vitally important as that is. It is also about promoting economic development and the rule of law, and protecting public health.

The effect wildlife trafficking has on the broader social fabric is often lost. It lowers the economic value of legally traded goods, contributes to poverty, and encourages lawlessness. Wildlife crime is increasingly being seen as linked to other forms of organized crime such as drug, arms and human trafficking with criminal syndicates discovering this as a softer option to raise resources. Often the criminal proceeds of such crime are ploughed back into other forms of the illegal economy, further threatening the rule of law.

Despite key policy and political support, CITES implementation faces enormous challenges. In the present times, the nature and probable impacts of illegal wildlife trade are still not perceived to be of important enough at various levels of decision making. As such, it is a continuous challenge to focus resources and support towards meeting such threats. At times, concerns for biodiversity are projected and presented as "Anti development and growth". This is especially true for a country like India, with a billion plus human population, trying to balance the upkeep of its natural resources with the aspirations of its people. Amidst this, given the nature of the role assigned for it and the expanding nature of wildlife trade globally, the challenges faced by CITES are enormous. In addition to financial resources, the operation of CITES demand high levels of human resources, time and expertise. Issues like scientific assessment, capacity building, enforcement and implementation are also a challenge. Agreeing to a convention is one thing and providing timely responses and participating actively in its implementation is another. India will do well to work closely with its neighbors and other international partners and agencies to strengthen its response to the threats of wildlife crimes. Only then will we do true justice to our status and responsibility as a mega diverse country in the present.

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